STANDARD OPERATING PROCEDURES

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1.0 OBJECTIVE

The objective of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, sampling locations, and sampling frequency, for proper assessment of site characteristics.

2.0 APPLICABILITY

This SOP is applicable to all field activities which involve sampling.

3.0 DESCRIPTION

3.1 Purpose and Objectives of Sampling Activities

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The prime objective of all sampling activities is to characterize a waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of the sampling activities, and implementing the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.2 Types of Samples

Before defining the general sample types, the nature of the object or materials under investigation must be discussed.

Of least concern to the sampler are homogeneous materials. These materials are generally defined as having uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the quality of the material over distance, both laterally and vertically.

When discussing types of samples, it is important to distinguish between the type of media to be sampled and the sampling technique that yields a specific type of sample. In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are generally dilute (in terms of pollutant concentration) samples taken in an area surrounding a spill or dump site (i.e., off-site samples from soils, rivers, lakes, etc). They usually do not require the special handling procedures that are typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree (refer to SOP #2004, Sample Packaging and Shipment).

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to Department of Transportation (DOT) regulations and USEPA guidelines.

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or concentrated samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples are defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted,

however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing. Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure provides data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

3.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed will depend on the objective of the investigation. There are three basic approaches to sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a non-systematic fashion from the entire site, or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

3.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary and should be initiated in conjunction with, or immediately following, receipt of the work assignment notification. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities (refer to SOPs #2014 and #4025 for further details):

- Objective and purpose of the investigation.
- Basis upon which data will be evaluated.
- Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rational, and SOPs or description of the procedure to be implemented.

- o Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- o QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be an impractical undertaking in some instances. Emergency responses to accidental spills are a prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgement, and the sampling or response plans might be simply a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

3.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during subsequent litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include proceedings such as cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are non-defensible in court, and the consequent loss of enforcement proceedings.

4.0 RESPONSIBILITIES

4.1 **Task Leaders** - have responsibility to ensure sample integrity, maintain QA standards, and ensure that samples accurately represent the larger body of material under investigation by developing and implementing QAWPs.

4.2 **REAC Staff** - have responsibility to implement QAWPs for projects to which they are assigned.

4.3 **Site QC Coordinators** - have responsibility for ensuring field adherence and recording any deviations from the QAWP.

4.4 QA Officer and Section Chiefs - have responsibility for reviewing QAWPs and for proposing corrective action, if necessary, for nonconformity to the QAWP.

TABLE OF CONTENTS

1.0 OBJECTIVE

The objective of this Standard Operating Procedure (SOP) is to define the procedures for preparing and maintaining documentation which provides the details of field sampling activities. The sample documentation discussed in this procedure includes: site and personal logbooks, data sheets, sample labels, and chain of custody records and seals.

2.0 APPLICABILITY

This SOP is applicable to all field activities which involve the generation of environmental measurements.

3.0 DESCRIPTION

3.1 General

Accurate sample documentation is essential for proper site evaluation. A clear traceable paper trail must follow each sample from its point of origin to the final report. It is important that specific procedures be adopted so that the desired degree of accuracy is achieved.

All sample documents must be completed legibly and in ink. Any corrections or revisions must be made by lining through the incorrect entry and initialing the error.

3.2 Site Logbook

The site logbook is used to record data and observations so that an accurate account of field operations can be reconstructed in the writer's absence. There is the potential, especially on Superfund sites, for site logs to be used as legal evidence sometime in the future. The site logbook is essentially a descriptive notebook detailing site activities and observations. All entries should be dated and signed by the individual(s) making the entries and should contain at a minimum, the following information:

- Site name and location on inside cover.
- Date and location of field work.
- Times (military times preferred, or reference a.m. or p.m.).
- Names and addresses of field contacts.
- Site sketches and photographic references.
- Weather conditions, (Optional if provided on field data sheets. See Section 3.4.1).
- Sample descriptions, locations, times taken, identification numbers, (Optional if provided on field data sheets. See Section 3.4.1).
- Chain of custody information, shipping paper identification number, recipient address and phone number, etc.
- Field observations and discussion, (Optional if provided on field data sheets. See Section 3.4.1).
- Field measurements (i.e., pH, temperature, surface water flow rates, etc.), (Optional if provided on field data sheets. See Section 3.4.1).
- Instructions issued by the Work Assignment Manager.

Entries may be made in site logbooks by any ERT or REAC personnel on site and should not simply detail the activities of one person involved in the field operations. Each entry should be signed by the person making the entry and should relate to previous entries or have sufficient background detail. The sequence of site activities should be clear to a reader who was not at the site.

When a site logbook is completed, no longer needed for site documentation, or a project is completed, the site logbook must be transmitted to the appropriate Work Assignment folder of the Central File. If the site logbook is transmitted to the ERT, documentation of the transmittal must be prepared and maintained in the Central File.

3.3 Personal Logbooks

When involved in field operations, all REAC personnel will maintain a personal logbook. The personal logbook will be a chronologic compilation of the individual's daily field activities. Personal logbooks are to be maintained, even if a REAC member is entering information in a site log. The personal logbook may reference the site logbook, but must also identify what, if any, work was performed when not on-site. In the absence of a dedicated site logbook, the personal logbook must detail all site related activities that would typically be entered in a site logbook.

Personal logbooks may be maintained for the individual's daily office activities at the discretion of the individual. When a REAC member is in the office, the personal logbook should contain, at a minimum, meetings attended and meeting notes, telephone conversations, and detail of any work performed that relates to a particular site. Any task related entries should include the Work Assignment Number. Entries should include, but are not limited to, the following:

- Field and project-related activities performed.
- Directives from Work Assignment Manager.
- Verbal instructions from EPA personnel.
- Personal injuries or potential exposures.
- Phone conversations relevant to work assignments.

When a personal logbook is completed or the person to whom it is assigned leaves REAC, the personal logbook shall be transmitted to the Quality Assurance Officer. People who must access information in a personal logbook may obtain photocopies from the person to whom the logbook is assigned.

If personal logbooks are used for site-related information in lieu of a dedicated site logbook, the REAC Task Leader must obtain copies of the site notes from each individual task member and transmit these notes under a standard cover memo (Appendix A, Figure 1) to the Central File. This must be completed within ten (10) working days of completion of field activities.

3.4 Field Data Sheets and Sample Labels

Field data sheets and corresponding sample labels are used to identify samples and document

field sampling conditions and activities. There are several different field data sheets and sample labels used within the REAC project.

Field data sheets will be maintained by the Task Leader or designee; and at a minimum, originals will be filed in the Central File, usually as attachments to Trip or Final Reports.

3.4.1 General Field Data Sheets and Sample Labels

Pre-numbered field data sheets and corresponding, pre-numbered sample labels (Appendix A, Figures 2 and 3, respectively) are used for all types of samples except soil gas and air samples (see Sections 3.4.2 and 3.4.3 below).

Upon sample collection at a particular sampling location, field data sheet(s) shall be completed with the following information:

1. Site name, sampling location, date and time of sampling, name(s) of sampler(s), chain of custody record number, REAC Task Leader's name, EPA Work Assignment Manager's name, and the Work Assignment Number.

2. Site description, and as applicable, soil type, surface water, stream, and bottom information.

3. Sample type, sampling device, sample information (ex., color, odor, temperature, pH, etc.) and weather parameters.

4. Analyses to be performed and sample preparation information.

Also upon sample collection, the corresponding pre-numbered sample labels must be completed and securely affixed to the sample container(s).

Because samples are often collected from the same location in more than one container (for more than one analysis), the sample label consists of several parts (Appendix A, Figure 3). The largest part of the sample label consists of the project name and EPA contract number, the unique sample identification number consisting of the prefix "A" followed by a five digit number (AXXXXX), and spaces for inserting the following information: site name, Work Assignment Number, date and time of collection, the analysis requested, and the preservative. Other parts of the sample label include additional sample labels numbered with the same sample identification number and consecutive letter prefixes (BXXXXX to LXXXXX).

When a sample is collected in only one container, the largest part of the sample label is completed and affixed to the sample container. When the sample is collected in multiple containers, the largest part of the sample label is completed and affixed to one of the sample containers, and the additional labels, beginning with letter prefix "B", are affixed to the additional containers in a consecutive order. If more than 12 containers are included in a sample set, then the sampler may use blank labels and insert the sample identification number beginning with letter prefix "M" (MXXXXX).

If duplicates or blanks are collected at a sampling location, the sample sets must be treated as being unique from the original sample and labelled with different sample identification numbers (e.g., AYYYYY to LYYYYY). When collecting matrix spike/matrix spike duplicate (MS/MSD) samples, the original sample container(s) and all MS/MSD containers are labelled with the same sample identification number and consecutive letter prefixes (e.g., If the sample was collected in 6 containers and a set of MS/MSD samples is required, then the sample labelling scheme would begin with AXXXXX and continue to RXXXXX).

3.4.2 Soil Gas Sampling Data Sheets and Sample Labels

Soil gas sampling data sheets and pre-numbered sample labels (Appendix A, Figures 4 and 5, respectively) are used for all soil gas sampling activities.

The heading of the data sheets shall be completed with the following information: site name, samplers, date, REAC Task Leader, EPA Work Assignment Manager, the project number, and the weather parameters.

After the soil gas well is screened with field instrument(s), the location identification, pertinent remarks, time, depth, and the instrument reading(s) are recorded in the first available column on the soil gas sampling data sheet. A total of five (5) columns are available to record data from five sampling points on each soil gas sampling data sheet.

If a soil gas sample was collected at that particular location, "Y" is circled to indicate this. The soil gas sample label is completed with the site name, sample location, date, time, remarks, and instrument readings; the label is then affixed to the sample container (see SOP #2149, Soil Gas Sampling, for the specific method). A corresponding sample label (with sample identification number only) is inserted on the sample number line in the appropriate column on the soil gas sampling data sheet. If a soil gas sample was not collected at that particular location, "N" is circled to indicate this.

If necessary, the additional sample label (with the sample identification number only) can be inserted in the logbook used for documenting sampling activities or, can be used for additional sample containers if the sample is collected in multiple containers. Blank sample labels are also provided so that sample numbers can be written in, when needed.

Trip standards, field blanks, and samples containing spikes must be assigned unique sample identification numbers. Soil gas sampling data sheets and sample labels will be prepared and maintained for these types of samples in the same manner as for the field samples.

3.4.3 Air Sampling Worksheets and Sample Labels

Air sampling worksheets and pre-numbered sample labels (Appendix A, Figures 6 and 7, respectively) are used for all air sampling activities.

The heading of the air sampling worksheet is completed with the following information: site name, samplers, date, Work Assignment Number, EPA Work Assignment Manager,

and the REAC Task Leader.

When air sampling is initiated, the following information is recorded in the first available column on the air sampling worksheet: sample number, sample location, remarks, pump number, collection media, time of day, start time/counter, and start flow rate. At the end of the sampling period, the stop time/counter, the stop flow rate, and whether or not a pump fault occurred are recorded. A total of five (5) columns are available to record data from five sampling locations on each air sampling worksheet.

The total sampling time is calculated by subtracting the start time/counter value from the stop time/counter value. The average flow rate is calculated from the start and stop flow rates. The volume sampled is calculated by multiplying the total sampling time by the average flow rate. All calculated values, along with the analysis requested, are recorded in the appropriate location on the air sampling worksheets.

If real-time air monitoring instruments are used at a particular sample location, the instrument readings are also recorded on the air sampling worksheet. If air samples are collected outdoors, then the appropriate weather parameters are also recorded on the air sampling worksheet.

The pre-numbered air sample label (Appendix A, Figure 7) consists of several parts. The largest part includes the project name, the contract number, the sample identification number, and space for the following information: the site name, volume of air, date, time, requested analysis, and remarks. Other parts include two additional sample labels with the sample identification number only.

When a sample is collected, the largest part of the sample label is completed and affixed to the sample container in the manner described by the appropriate ERT/REAC air sampling SOP. If samples are collected from a single sampling location in more than one sample media, the blank space at the end of the sample identification number is used to indicate the media and the small sample labels are affixed to the additional sample containers. If available, the small sample labels may be inserted in the sample number space in the appropriate column on the air sampling worksheet. Blank sample labels are provided for use as necessary.

Alternatively, at the Task Leader's discretion, separate sample numbers may be used for each media in which sample are collected at a single sampling location. In this case, the largest part of the sample label will be completed and affixed to the sample container in the manner described by the appropriate ERT/REAC air sampling SOP. The small sample labels (with sample identification number only) will be affixed to the air sampling worksheet and the logbook.

QC samples must be assigned unique sample identification numbers. Air sampling worksheets and pre-numbered sample labels will be prepared and maintained in the same manner as for the field samples.

3.4.4 Specialized Field Data Sheets

Task Leaders, with the concurrence of the Group Leader, the Work Assignment Manager, and the QA Officer, may develop specialized field data sheets if none of the three types described above meet the specific needs of the task. At a minimum, the field data sheet should include space for recording the name(s) of the sampler(s), the sample number(s), the location of the sample point, the date and time that the sample was taken, and any pertinent field conditions. The following information will be included in the header of the data sheet: (Matrix) Data Sheet, Roy F. Weston, Inc., REAC, Edison, NJ, EPA Contract: 68-03-3482.

3.5 Chain of Custody

A chain of custody record (Appendix A, Figure 8) must be maintained from the time a sample is taken to the final deposition of the sample (see SOP #4010, Chain of Custody, for further details).

The chain of custody record shall contain, at a minimum, the following information: project name, project number, the REAC contact and their telephone number. For each sample collected, the chain of custody record shall include the sample number, sampling location, sample matrix, date collected, container/preservative, the analysis requested, and special instructions, if any are applicable.

Chain of custody records must be completed legibly, with all required information, so that miscommunication with, or misunderstanding by, the receiving laboratory can be prevented.

If samples collected during a sampling event are being forwarded to more than one laboratory, then a separate chain of custody record, indicating which samples are being sent to that particular laboratory, must be completed for each laboratory.

The chain of custody provides a means by which a court or other proceeding can trace the entire path and life of a sample. Every transfer of custody must be noted and signed for on the chain of custody record. If a sample or group of samples is not under direct control or observation of the individual responsible for the samples, then they must be stored in a locked container that has been sealed with a chain of custody seal (Section 3.6). A copy of the chain of custody record should be kept by each individual who has signed it. The final copy should be included with the Analytical Report.

3.6 Chain of Custody Seals

Chain of custody seals (Appendix A, Figure 9) demonstrate that a sample container has not been opened or tampered with during transport or storage of samples. The seal or seals should be affixed in such a manner that the container cannot be opened without breaking the seal. The person in direct possession of the samples shall sign and date the seal. The name of the individual signing the seal and a description of the packaging shall be noted in the site logbook.

4.0 RESPONSIBILITIES

4.1 Task Leaders and field staff - have responsibility for preparing and maintaining sample documentation as described in this SOP.

4.2 Section Chiefs and QA Officer - have responsibility for ensuring implementation of the procedures outlined in this SOP.

APPENDIX A

FIGURES
SOP #2002
AUGUST, 1990

FIGURE 1

COVER MEMO - TRANSMITTAL OF SITE NOTES

WESTON MANAGERS DESIGNERS/CONSULTANTS
REAC SUPPORT ORGANIZATION
OSA RARITAN DEPOT
WOODBRIDGE AVENUE
BUILDING 209 BAY #
EDISON NJ 08837
PHONE 201-632-3200

TO: Central File # _____

FROM: _____, Task Leader

DATE:

SUBJECT: FIELD LOGBOOK NOTES
SITE NAME, DATE(s)

Attached please find copies of field logbook records for activities performed at the above referenced site. Individuals involved included:

NAME	LOGBOOK NUMBER
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

w/Attachments

eh\ANDREAS\LOGBOOK

FIGURE 2

FIELD DATA SHEET

FIELD DATA SHEET

Roy F. Weston, Inc.
REAC, Edison, N.J.
EPA Contract 68-03-3482

7872

Chain of Custody No _____
Samplers _____ REAC Task Leader _____
Date _____ Site Name _____ EPA WAM _____
Time _____ Sample Location _____ Work Assignment No _____

SITE DESCRIPTION			SOIL TYPE		SURFACE WATER	STREAM	BOTTOM	
landfill	old field	upland palustrine	rock	clay	color _____	width _____	rock	silt
industrial	wooded	overland riverine	gravel	muck	odor _____	depth _____	rubble	clay
commercial	farmland	lacustrine	sand	loam	flow _____	velocity _____ cm/s	gravel	organic
residential	gully		silt	peat	direction _____	pools _____ %	shell	other _____
hedgerows	floodplain		color _____			riffles _____ %	sand	

SAMPLE TYPE		DEVICE		SAMPLE INFORMATION		WEATHER PARAMETERS	
surface water	effluent	remmerer	ponar	color _____	pH _____	ambient temp _____	
groundwater	sludge	trowel	other _____	odor _____	ORP _____	barometric pressure _____	
potable water	leachate	bucket		temp _____	salinity _____	relative humidity _____	
sediment	waste	auger		DO _____	sample depth _____	weather conditions _____	
soil	other _____	ekman		cond _____	tide stage _____		

ANALYSES TO BE PERFORMED

ORGANICS
- A. halogenated & aromatic volatiles
- B. volatiles
- C. trihalomethanes
- D. pesticides/PCB
- E. PCB
- F. base neutral/acid extractables
- G. pesticides, drinking water
- H. herbicides, drinking water
- I. other _____

INORGANICS
- A. metals, priority pollutants
- B. metals, TAL
- C. metals scan (ICP)
- D. metals, other _____

RCRA
- A. TCLP
- B. ignitability
- C. corrosivity _____ pH _____
- D. reactivity
- E. other _____

OTHER ANALYSIS
- A. total cyanide
- B. total phenol
- C. petroleum hydrocarbons
- D. pH
- E. alkalinity
- F. hardness
- G. total dissolved solids
- H. total suspended solids
- I. sulfate
- J. TOC
- K. Grain Size
- L. other _____
- M. other _____

SAMPLE PREPARATION

CONTAINER	PRESERVATIVES
glass jar	HNO_3
plastic jar	NaOH
acetate core	Zn Acetate
plastic bag	HCl
plastic bucket	Na_2SO_4
other _____	other _____

STORAGE
- wet ice
- dry ice
- ambient

COMMENTS:

FIGURE 3

SAMPLE LABELS

ROY F. WESTON, INC. REAC EDISON NJ EPA Contract 68-03-3482	SAMPLE NO A 07872
SITE NAME	DATE
WORK ORDER NO	TIME
ANALYSIS REQUESTED	
PRESERVATIVE ☐ NONE ☐ SULFURIC ACID ☐ OTHER(Specify) ☐ COOL(4°C) ☐ SODIUM HYDROXIDE ☐ NITRIC ACID ☐ SODIUM THIOSULFATE	

B 07872
C 07872
D 07872
E 07872
F 07872
G 07872
H 07872
I 07872
J 07872
K 07872
L 07872

FIGURE 4

SOIL GAS SAMPLING DATA SHEET

SOIL GAS SAMPLING DATA SHEET

ROY F. WESTON, INC.
REAC, EDISON, N.J.
EPA CONTRACT: 68-03-3482

Site Name: _____ REAC Task Leader: _____

Samplers: _____ EPA Work Assignment Manager: _____

Date: _____ Project No.: _____

Weather Parameters: ambient temp _____ relative humidity _____
barometric pressure _____ weather conditions _____

Sample No.:	_____	_____	_____	_____	_____
Location ID:	_____	_____	_____	_____	_____
Remarks:	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____
Time:	_____	_____	_____	_____	_____
Sample Depth:	_____	_____	_____	_____	_____
Sample Taken:	Y/N	Y/N	Y/N	Y/N	Y/N

Instrument Readings:

HNU	_____	_____	_____	_____	_____
OVA	_____	_____	_____	_____	_____
LEL	_____	_____	_____	_____	_____
% O_2	_____	_____	_____	_____	_____
Soil Temp	_____	_____	_____	_____	_____
Other	_____	_____	_____	_____	_____

General Comments:

eh/MATEO/DATA-SHEET

FIGURE 5

SOIL GAS SAMPLE LABELS

Roy F. Weston, Inc. REAC, EDISON, NJ SAMPLE NO. SG 00001 EPA CONTRACT 68-03-3482 SITE NAME: DATE: TIME: SAMPLE LOCATION: REMARKS: HNu ____ % O_2 ____ OVA ____ SOIL TEMP ____ LEL ____ OTHER ____	SG 00001 SG 00001 SG 00002 SG 00002 10
Roy F. Weston, Inc. REAC, EDISON, NJ SAMPLE NO. SG 00003 EPA CONTRACT 68-03-3482 SITE NAME: DATE: TIME: SAMPLE LOCATION: REMARKS: HNu ____ % O_2 ____ OVA ____ SOIL TEMP ____ LEL ____ OTHER ____	SG 00003 SG 00003 SG 00004 SG 00004 10
Roy F. Weston, Inc. REAC, EDISON, NJ SAMPLE NO. SG 00005 EPA CONTRACT 68-03-3482 SITE NAME: DATE: TIME: SAMPLE LOCATION: REMARKS: HNu ____ % O_2 ____ OVA ____ SOIL TEMP ____ LEL ____ OTHER ____	SG 00005 SG 00005 SG 00006 SG 00006 10
Roy F. Weston, Inc. REAC, EDISON, NJ SAMPLE NO. SG 00007 EPA CONTRACT 68-03-3482 SITE NAME: DATE: TIME: SAMPLE LOCATION: REMARKS: HNu ____ % O_2 ____ OVA ____ SOIL TEMP ____ LEL ____ OTHER ____	SG 00007 SG 00007 SG 00008 SG 00008 10
Roy F. Weston, Inc. REAC, EDISON, NJ SAMPLE NO. SG 00009 EPA CONTRACT 68-03-3482 SITE NAME: DATE: TIME: SAMPLE LOCATION: REMARKS: HNu ____ % O_2 ____ OVA ____ SOIL TEMP ____ LEL ____ OTHER ____	**Roy F. Weston, Inc.** REAC, EDISON, NJ SAMPLE NO. SG 00010 EPA CONTRACT 68-03-3482 SITE NAME: DATE: TIME: SAMPLE LOCATION: REMARKS: HNu ____ % O_2 ____ OVA ____ SOIL TEMP ____ LEL ____ OTHER ____	SG 00009 SG 00009 SG 00010 SG 00010 10

FIGURE 6

AIR SAMPLING WORKSHEET

ENVIRONMENTAL RESPONSE TEAM
AIR SAMPLING WORKSHEET

Roy F. Weston, Inc.
REAC Project, Edison, NJ
EPA Contract No. 68-03-3482

SITE _____ W.A. # _____
SAMPLERS _____ EPA WAM _____
DATE _____ REAC TL _____

SAMPLE NO.					
Sample Location					
Remarks					
Pump No.					
Collection Media					
Time of Day					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Sampling Time					
Pump Fault	Y/N	Y/N	Y/N	Y/N	Y/N
Flow Rate (Start)					
Flow Rate (Stop)					
Flow Rate (Average)					
Volume Sampled					
Analysis Requested					
Air Monitoring Data					
HNU					
OVA					
LEL/RAM					
_____					

WEATHER PARAMETERS
Weather Conditions _____ Temperature ____ Windspeed ____
Wind direction ____ Pressure ____ Humidity ____ Met ID ____

GENERAL COMMENTS:

rd/BATZ/WORKSHEET

FIGURE 7

AIR SAMPLE LABELS

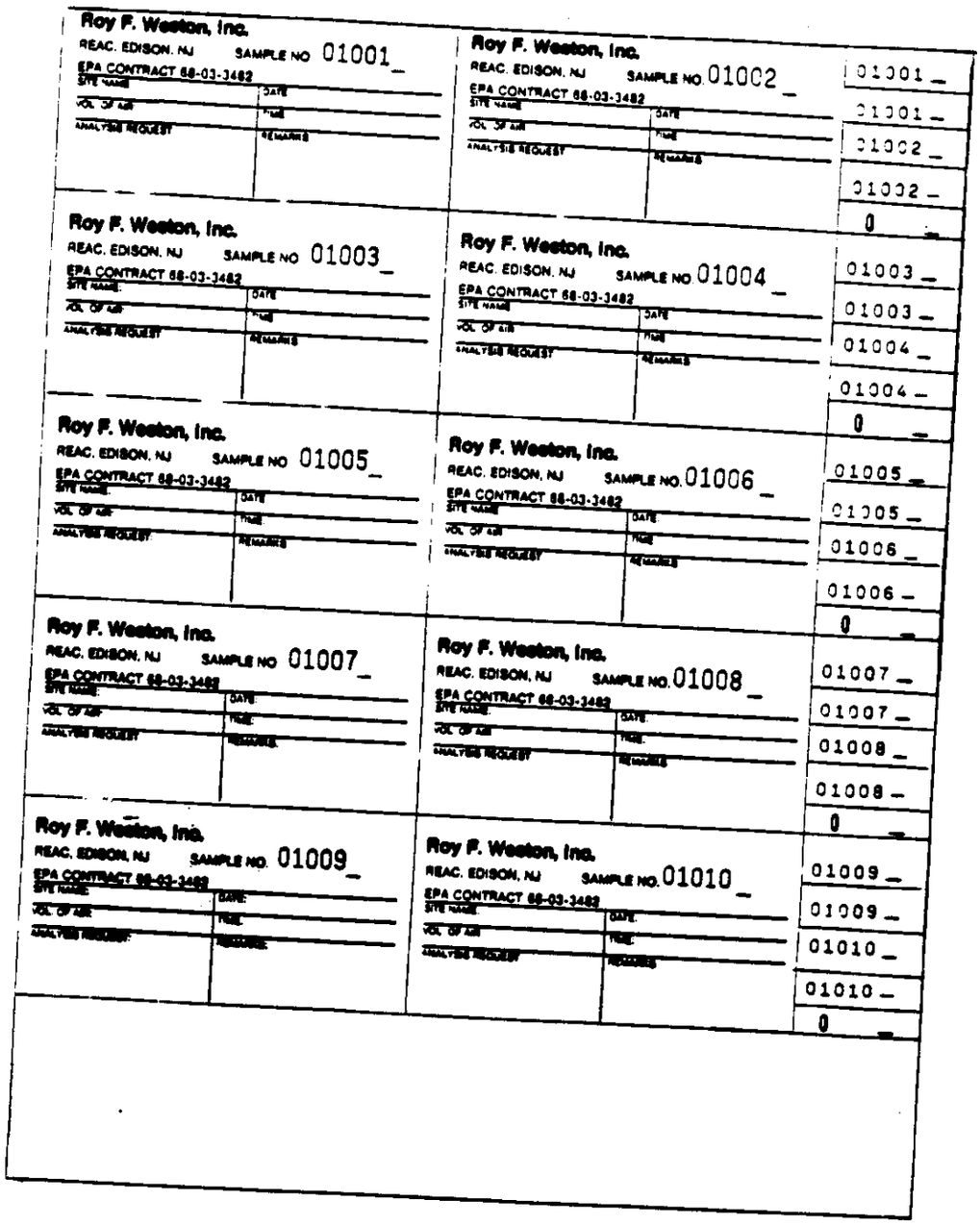

FIGURE 8

CHAIN OF CUSTODY RECORD/LAB WORK REQUEST

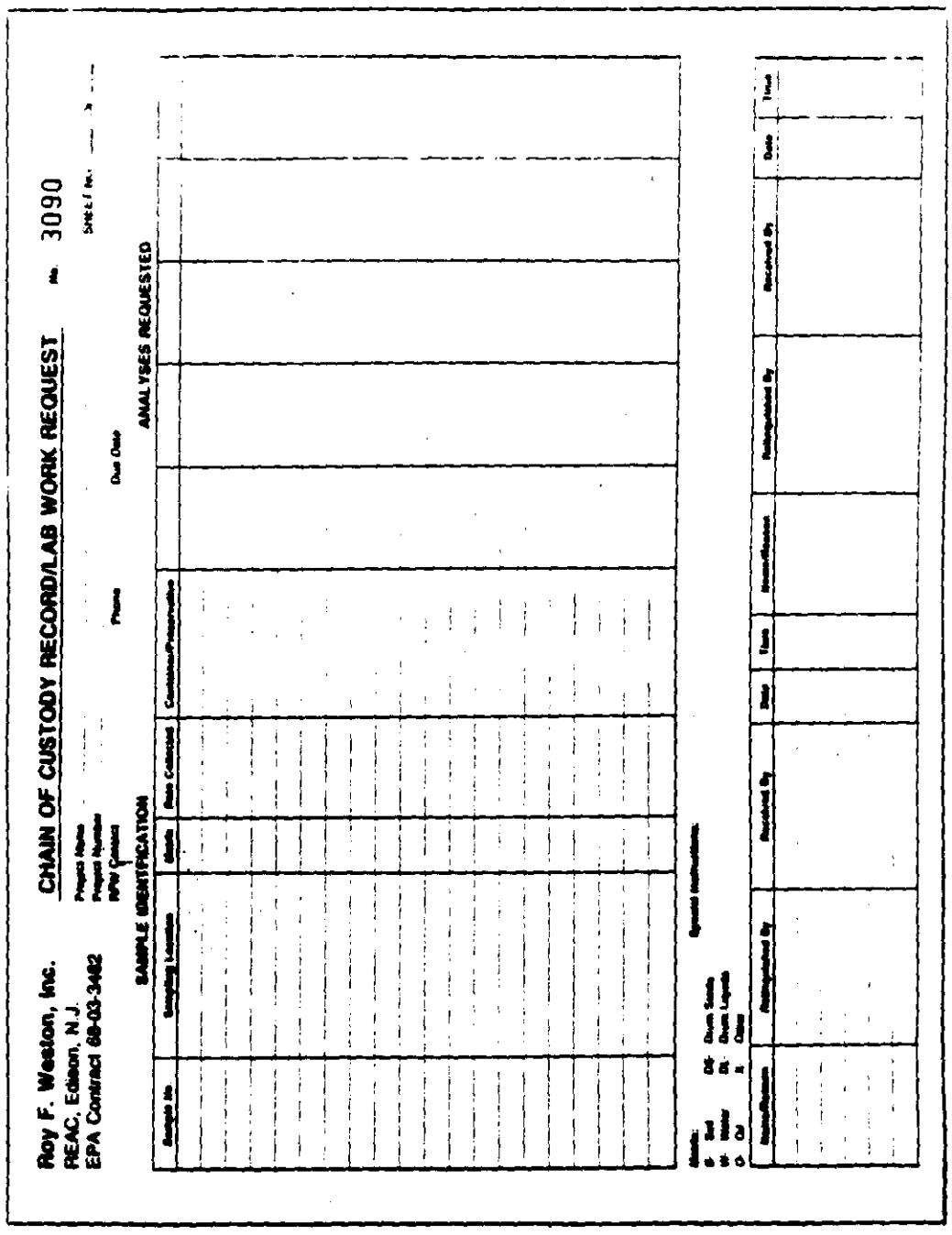

FIGURE 9

CHAIN OF CUSTODY SEALS

WESTON Date CUSTODY SEAL Signature	WESTON Date CUSTODY SEAL Signature

1.0 OBJECTIVE

The objective is to provide general guidelines and establish Standard Operating Procedures for the collection and preservation of samples of varying composition and matrix. Procedures for container size and type and preservation techniques are presented for both individual parameters and groups of parameters.

2.0 INTRODUCTION

The S&A section of REAC assists the O&A section by providing both in-house and contract lab analytical services for samples collected from hazardous waste sites. These services involve the selection of commercial labs, establishing sample analysis turnaround time, expediting sample analysis, and assisting O&A in the preparation of final reports. The analytical parameter groups for which the O&A section will most often be sampling are discussed, along with the amount of sample required, and any necessary preservation steps, according to 40 CFR Part 136.

3.0 PRIORITY POLLUTANTS

The EPA has listed 126 priority toxic pollutants. Of these, 111 are organic and 15 are inorganic. These pollutants are broken down into groups (Table 1) which are based on the test procedures used in their measurement. The sample matrix is municipal and industrial wastewater.

3.1 Organochlorine Pesticides and PCB's

The following 25 parameters can be determined by EPA Method 608:

PARAMETER	STORET NO.	CAS NO.
Aldrin	39330	309-00-2
Alpha-BHC	39337	319-84-6
Beta-BHC	39338	319-85-7
Gamma-BHC	34259	319-86-8
Delta-BHC	39340	58-89-9
Chlordane	39350	57-74-9
4,4' -DDD	39310	72-54-8
4,4' -DDE	39320	72-55-9
4,4' -DDT	39300	50-29-3
Dieldrin	39380	60-57-1

Endosulfan I		34361	959-98-8
Endosulfan II		34356	33212-65-9
Endosulfan sulfate		34351	1031-07-8
Endrin	39390	72-20-8	
Endrin aldehyde		34366	7421-93-4
Heptachlor		39410	76-44-8
Heptachlor epoxide		39420	1024-57-3
Toxaphene	39400	8001-35-2	
PCB-1016	34671	12674-11-2	
PCB-1221	39488	1104-28-2	
PCB-1232	39492	11141-16-5	
PCB-1242	39496	53469-21-9	
PCB-1248	39500	12672-29-6	
PCB-1254	39504	11097-69-1	
PCB-1260	39508	11096-82-5	

Sample collection, preservation, and handling must be done as follows:

Collection Technique - Grab or composite
Container - Glass, Teflon® - lined cap
Preservation - Cool, 4 degrees C
Holding Time - 7 days until extraction, 40 days after extraction

Minimum Required Volume - Two 1000 ml containers (water)
- One 8 oz container (soil)

Grab samples must be collected in glass containers. Conventional sampling practices should be followed, except that the bottle must not be prerinsed with sample before collection. Composite samples should be collected in refrigerated glass containers in accordance with the requirements of the program. Automatic sampling equipment must be free as possible of Tygon tubing and other possible sources of contamination.

All samples must be iced or refrigerated at 4^{0} C from the time of collection until extraction. If the samples will not be extracted within 72 hours of collection, the sample should be adjusted to a pH range of 5.0 to 9.0 with sodium hydroxide solution or sulfuric acid. Record the volume of acid or base used. If aldrin is to be determined, add sodium thiosulfate when residual chlorine is present. EPA Methods 330.4 and 330.5 can be used to measure residual chlorine. Field test kits are commercially available for this purpose.

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3.2 PURGEABLES

The following 31 parameters can be determined by EPA Method 624:

Parameter	STORET No.	CAS No.
Benzene	34030	71-43-2
Bromodichloromethane	32101	75-27-4
Bromoform	32104	75-25-2
Bromomethane	34413	74-83-9
Carbon tetrachloride	32102	56-23-5
Chlorobenzene	34301	108-90-7
Chloroethane	34311	75-00-3
2-Chloroethylvinyl ether	34576	110-75-8
Chloroform	32106	67-66-3
Chloromethane	34418	74-87-3
Dibromochloromethane	32105	124-48-1
1,2-Dichlorobenzene	34536	95-50-1
1,3-Dichlorobenzene	34566	541-73-1
1,4-Dichlorobenzene	34571	106-46-1
1,1-Dichloroethane	34496	75-34-3
1,2-Dichloroethane	34531	107-06-2
1,1-Dichloroethane	34501	75-35-4
trans-1,2-Dichloroethane	34546	156-60-5
1,2-Dichloropropane	34541	78-87-5
cis-1,3-Dichloropropane	34704	10061-01-5
trans-1,3-Dichloropropane	34699	10061-02-6
Ethyl benzene	34371	100-41-4
Methylene chloride	34423	75-09-2
1,1,2,2-Tetrachloroethane	34516	79-34-5
Tetrachloreothene	34475	127-18-4
Toluene	34010	108-88-3
1,1,1-Trichloroethane	34506	71-55-6
1,1,2-Trichloroethane	34511	79-00-5
Trichloroethene	39180	79-01-4
Trichlorofluoromethane	34488	75-69-4
Vinyl chloride	39175	75-01-4

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Sample collection, preservation, and handling must be done as follows:

Collection Technique- Grab only
Container- Glass, Teflon^{R}- lined cap
Preservation- Cool, 4^{o} C
Holding Time- 14 days
Minimum Required Volume- Three 40ml purge vials

All samples must be iced or refrigerated from the time of collection until analysis. If the sample contains residual chlorine, add sodium thiosulfate preservative (10 mg/40 ml is sufficient for up to 5 ppm chlorine) to the empty sample bottle just prior to shipping to the sampling site. EPA Methods 330.4 and 330.5 may be used for measurement of residual chlorine. Field test kits are commercially available for this purpose.

Grab samples must be collected in glass containers having a total volume of at least 25 ml. Fill the sample bottle just to overflowing so that no air bubbles pass through the sample as the bottle is being filled. Seal the bottle so that no air bubbles are entrapped in it. If preservative has been added, shake vigorously for 1 minute. Maintain the hermetic seal on the bottle until analysis.

Experimental evidence indicates that some aromatic compounds, notably benezene, toluene, and ethyl benzene are susceptible to rapid biological degradation under certain environmental conditions. Refrigeration may not be adequate to preserve these compounds in wastewaters for more than 7 days. For this reason, a separate sample should be collected, acidified, and analyzed when these aromatics are to be determined. Collect about 500 ml of sample in a clean container. Adjust the pH of the sample to about 2 by adding 1+1 HCl while stirring vigorously. Check pH with narrow range (1.4 to 2.8) pH paper. Fill a sample container as described above.

Note: For the determination of acrolein and acrylonitrile an additional 40ml sample should be collected and preserved as above. EPA method 603 would then be used to determine these compounds.

3.3 EXTRACTABLES (BASE NEUTRALS AND ACIDS)

EPA Method 625 covers the determination of a number of organic compounds that are partitioned into an organic solvent and are amenable to gas chromatography. The parameters listed below may be qualitatively and quantatively determined using this method.

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BASE/NEUTRAL EXTRACTABLES

Parameter	STORET No.	CAS No.
Acenaphthene	34205	83-32-9
Acenaphthylene	34200	208-96-8
Anthracene	34220	120-12-7
Aldrin	39330	309-00-2
Benzo (a) anthracene	34526	56-55-3
Benzo (b) fluoranthene	34230	205-99-2
Benzo (k) fluoranthene	34242	207-08-9
Benzo (a) pyrene	34247	50-32-8
Benzo (ghi) perylene	34521	191-24-2
Benzyl butyl phthalate	34292	85-68-7
Bis (2-chloroethyl) ether	34273	111-44-4
Bis (2-chloroethoxy) methane	34278	111-91-1
Bis (2-ethylhexyl) phthalate	39100	117-81-7
Bis (2-chloroisopropyl) ether	34283	108-60-1
4-Bromophenyl phenyl ether	34636	101-55-6
2-Chloronaphthalene	34581	91-58-7
4-Chlorophenyl phenyl ether	34641	7005-72-3
Chrysene 34320	218-01-9	
Dibenzo (a,h) anthracene	34556	53-70-3
Di-n-butylphthalate	39110	84-74-2
1,3-Dichlorobenzene	34566	541-73-1
1,2-Dichlorobenzene	34536	95-50-1
1,4-Dichlorobenzene	34571	106-46-1
3,3'-Dichlorobenzidine	34631	91-94-1
Diethyl phthalate	34336	84-66-2
Dimethyl phthalate	34341	131-11-3
2,4-Dinitrotoluene	34611	121-14-2
2,6-Dinitrotoluene	34626	606-20-2
Di-n-octylphthalate	34596	117-84-0

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Fluoranthene	34376	206-44-0
Fluorene 34381	86-73-7	
Hexachlorobenzene	39700	118-17-1
Hexachlorobutadiene	34391	87-68-3
Hexachloroethane	34396	67-72-1
Indeno (1,2,3-cd) pyrene	34403	193-39-5
Isophorone	34408	78-59-1
Naphthalene	34696	91-20-3
Nitrobenzene	34447	98-95-3
N-Nitrosodi-n-propylamine	34428	621-64-7
Phenanthrene	34461	85-01-8
Pyrene	34469	129-00-0
1,2,4-Trichlorobenzene	34551	120-82-1

ACID EXTRACTABLES

Parameters	STORET No.	CAS No.
4-Chloro-3-methylphenol	34452	59-50-7
2-Chlorophenol	34586	95-57-8
2,4-Dichlorophenol	34601	120-83-2
2,4-Dimethylphenol	34606	105-67-9
2,4-Dinitrophenol	34616	51-28-5
2-Methyl-4,6-dinitrophenol	34657	534-52-1
2-Nitrophenol	34591	88-75-5
4-Nitrophenol	34646	100-02-7
Pentachlorophenol	39032	87-86-5
Phenol	34694	108-95-2
2,4,6-Trichlorophenol	34621	88-06-2

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Sample collection, preservation, and handling must be done as follows:

Collection Technique- Grab or Composite
Container - Glass, Teflon®-lined cap (amber glass for liquids)
Preservation - Cool, 4° C
Holding Time - 7 days until extraction, 30 days after extraction
Minimum Required Volume - Two 1000 ml containers (water)
- One 8 oz container (soil)

All samples must be iced or refrigerated from the time of collection until analysis.

3.4 METALS

Listed below are the priority pollutant metals

Antimony (total)
Arsenic (total)
Beryllium (total)
Cadmium (total)
Chromium (total)
Copper (total)
Lead (total)
Mercury (total)
Nickel (total)
Selenium (total)
Silver (total)
Thallium (total)
Zinc (total)

Sample collection, preservation and handling must be done as follows:

Collection Technique - Grab or composite
Container - Polyethylene
Preservation - Nitric acid to pH 2 (water only)
Holding Time - 6 months, except Hg - 28 days
Minimum Required Volume - 1000 ml (water)
- 8 oz (soil)

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3.5 TOTAL CYANIDE

Sample collection, preservation, and handling must be done as follows:

Collection Technique - Grab or composite
Container - Polyethylene
Preservation- NaOH to pH greater than 12 (water only)
Holding Time- 14 days
Minimum Required Volume - 1000 ml (water)
- 8 oz (soil)

Soil or sediment samples are collected in amber 8-oz jars with Teflon®-lined lids. The jars are filled to three-fourths capacity and no preservatives are used. If all priority pollutants are to be analyzed for, then collect 2-6oz. samples. If only organic or inorganic priority pollutants are to be analyzed for, then collect a single 6oz. sample.

4.0 RESOURCE CONSERVATION AND RECOVERY ACT ANALYSES

The Resource Conservation and Recovery Act (RCRA) is concerned with substances which, when improperly disposed, pose a threat to human health or the environment. RCRA evaluates the hazardous characteristics of these substances using the standard test methods of EP Toxicity, Reactivity, Corrosivity, and Ignitability.

4.1 EP TOXICITY

This analytical method is designed to simulate the leaching a waste undergoes if disposed of in an improperly designed sanitary landfill. The following contaminants may be determined by this procedure:

Arsenic
Barium
Cadmium
Chromium
Lead
Mercury
Selenium
Silver
Endrin
Lindane

Methoxychlor
Toxaphene
2,4-D
2,4,5-TP (Silvex)

Sample collection, preservation, and handling must be handled as follows:

Soil or sediment samples are collected in amber 8-oz glass jars with Teflon®-lined lids. The jars are to be filled to three-fourths capacity and no preservatives are used. Preservatives are not to be used but samples must be iced (4°C).

4.2 REACTIVITY

This method is used to identify cyanide- or sulfide-bearing wastes, which can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.

Soil or sediment samples are collected in amber eight ounce jars with Teflon-lined ~~jars~~ lids. The jars are to be filled to three-fourth capacity and no preservatives are used.

Aqueous samples are divided into cyanide and sulfide portions. For cyanides, collect 1000 ml in a polyethylene container. Preserve with NaOH to pH greater than 12, cool to 4°C. For sulfides, collect 1000 ml in a polyethylene container. Preserve with 4.0 ml of zinc acetate solution.

4.3 CORROSIVITY

This method is used to measure the corrosivity towards steel of both aqueous and nonaqueous liquid wastes. Collect 500 ml in a polyethylene container. Preservatives are not to be added.

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4.4 IGNITIBILITY

This method is used to identify wastes that either present fire hazards under routine storage, disposal and transportation or are capable of contributing to a fire once started.

Soil or sediment samples are collected in amber 8-oz glass jars with Teflon®-lined lids. The jars are to be filled to three-fourths capacity and no preservatives are to be used.

For aqueous samples collect 500 ml in an amber 8-oz glass jar with a Teflon®-lined lid. No preservatives are used.

5.0 SPECIAL ANALYTICAL REQUESTS

In addition to the above, O&A may be requested to sample for specialized or custom analytical requirements. Examples of such requirements include miscellaneous water and wastewater constituents, oil, asbestos, dioxins and low-level radioactive samples. In such cases, S&A will specify which collection, preservation and handling procedures to follow.

6.0 APPLICABILITY

The Standard Operating Procedures presented here will be applied by all REAC personnel when sampling any matrix or combination of matrices (excluding air) for any parameter or group of parameters discussed herein.

SAMPLE CONTAINERS, PRESERVATIVES, VOLUMES TO BE COLLECTED, AND HOLDING TIMES

Analysis	Matrix	Container	Preservation	Holding Times	Volume to Sample
Acidity/ Alkalinity	Water	P or G	Cool 4°C	14 days	1 liter
	Soil	P or G	Cool 4°C	14 days	8 oz
BOD	Water	G	Cool 4°C	48 hours	500 ml
COD	Water	P or G	Cool 4°C H_2SO_4 pH<2	28 days	500 ml
Cyanide	Water	P	Cool 4°C NaOH pH>12	14 days	1 liter
	Soil	G	Cool 4°C	14 days	8 oz
Phenols (total)	Water	G	Cool 4°C H_2SO_4 pH<2	28 days	1 liter
	Soil	G	Cool 4°C	28 days	8 oz
Volatiles (VOA)	Water	G (40 ml vial)	Cool 4°C*	14 days	(3) -40 ml vial
	Soil	G (40 ml vial)	Cool 4°C	14 days	(3) -40 ml vial
Base-Neutrals and Acid Extractables	Water	G (amber)	Cool 4°C	7 days	2 liters
	Soil	G	Cool 4°C	7 days	8 oz
Pesticide/PCBs	Water	G (amber)	Cool 4°C*	7 days	2 liters
	Soil	G	Cool 4°C	7 days	8 oz
Priority Pollutant Metals	Water	P or G	HNO_3 pH<2	28 days	1 liter
	Soil	G	Cool 4°C	28 days	8 oz
Grain Size	Soil	G	--------	-------	32 oz
EP Toxicity (Metals, Pest, Herbicides)	Soil	G	--------	-------	16 oz
Dioxin	Water	G	Cool 4°C*	-------	2 liters
	Soil	G	Cool 4°C	-------	16 oz

P - denotes polyethylene
G - denotes glass
* - if residual chlorine is present, should be preserved with 0.008% $Na_2S_2O_3$
(For example, a tapwater sample from a city water supplied residence.)

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1.0 OBJECTIVE

The objective is to provide a summary of applicable regulations and establish standard operating procedures for the packaging, labeling and shipping of hazardous and nonhazardous materials samples.

1.1 Definitions

DOT: U.S. Department of Transportation. This governing body regulates the shipment and handling of goods in commerce.

CFR: Code of Federal Regulations. This is a voluminous collection of federal laws and regulations. Title 49 contains all of the Department of Transportation regulations. Title 40 covers those regulations such as the Resource Conservation and Recovery Act.

RCRA: The Resource Conservation and Recovery Act enacted in 1980. RCRA specifies the laws and regulations governing the generation, transportation, treatment, storage and disposal of hazardous waste.

Hazardous Substance: Those chemicals listed in Section 302.4 of 40 CFR contains Clean Water Act, Clean Air Act, RCRA wastes have been assigned Reportable Quantity (RQ) designations for spills.

Hazardous Materials: Those chemicals listed in DOT 49 CFR.

2.0 INTRODUCTION

This section provides the sampler with an overview of the sometimes overwhelming body of federal regulations governing the packaging and shipment of various classifications of samples. The standard procedures necessary to fulfill both Federal and private carrier requirements are also considered.

3.0 SHIPPING REGULATIONS

After a sample has been collected, it must be packaged and shipped in a manner that will protect it from breakage or leakage. The effects of damage to the sample include the possible threat to human health or the environment, as well as the destruction of the sample, rendering it useless for laboratory analysis. The procedures and legal requirements instituted to insure against these effects are set forth in the U.S.

Department of Transportation (DOT), regulations governing the transportation of hazardous materials in commerce (49 CFR 171 through 178). It should be noted that International Air Transport Association (IATA) Dangerous Goods Regulations are tentatively scheduled to replace DOT regulations in 1989.

DOT's standard requirements for all packages are presented in 49 CFR 173.24(a). These requirements state that,

> "Each package used for shipping hazardous materials...shall be so designed and constructed, and its contents so limited, that under conditions normally incident to transportation:
>
> (1) There will be no significant release of the hazardous materials to the environment;
>
> (2) The effectiveness of the packaging will not be substantially reduced; and
>
> (3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase in heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging."

In addition, those samples shipped via air transport must meet the requirements of 49 CFR 173.6 (a,b), which state that:

> "When the regulations indicate a hazardous material is forbidden aboard cargo-aircraft only, the material is also forbidden aboard passenger-carrying aircraft.
>
> Each packaging must be designed and constructed to prevent leakage that may be caused by changes in altitude and temperature during air transportation.
>
> Inner containers that are breakable (such as earthenware, glass, or brittle plastic), must be packaged to prevent breakage and leakage under conditions normally incident to transportation. These completed packaging must be capable of withstanding a 4-foot drop on solid concrete in the position most likely to cause damage. Cushioning or absorbing agents must not be capable of reacting dangerously with the contents.

For any package with a capacity of 110 gallons or less containing liquids, sufficient outage (ullage) must be provided to prevent liquid contents from completely filling the packaging at 130°F. The primary packaging (which may include composite packaging), for which retention of the liquid is the basic function, must be capable of withstanding, without leakage, an internal absolute pressure of no less than 26 lbs./sq. inch or no less than the sum of the absolute vapor pressure of the contents at 130°F. (55°C) and the atmospheric pressure at sea level, whichever is greater."

With the passage of the Resource Conservation and Recovery Act, (RCRA-40 CFR 260-265), the EPA instituted its own regulations governing the generation, transportation, treatment, storage, and disposal of hazardous waste. In response to this, DOT revised its regulations to include the shipment of hazardous wastes, and EPA expressly adopted certain of these regulations. It is important to note however, that EPA specifically excluded samples collected for laboratory analysis from regulation under RCRA (40 CRF 261.4[d]. Therefore, waste samples must be shipped in accordance with applicable DOT regulations, and in conjunction with any regulations imposed by the contract carrier. All sample shipments should include the following information:

1. Name, address, and telephone number of the shipper
2. Name, address, and telephone number of the laboratory
3. Name of contact at the laboratory to whom the samples will be directed
4. Quantity contained in the sample(s)
5. Date of shipment
6. Description of the sample(s)

4.0 REGULATION OF ENVIRONMENTAL SAMPLES (LOW CONCENTRATION)

The term "Environmental sample" refers to those samples containing an environmental diluent such water and soil and therefore, not expected to be grossly contaminated (high hazard). For example, a sample taken from a sealed drum is a not classified as an environmental sample but a sample taken from a stream would meet the classification. Good judgement and

~~disgression~~ discretion should be utilized by the sampler whenever there is doubt as to the composition of the sample. No sample meeting the definition of any of the hazard classes listed in 49 CFR 172.101 should be considered environmental, nor should any sample with unknown composition be considered as such. Classification of samples of unknown composition is discussed in Section D.

Although samples classified as environmental are not considered hazardous by DOT, many of the standard preservatives are so classified. To resolve the apparent dilemma, EPA requested in 1979 an exemption from DOT regulations regarding preserved environmental samples.

DOT responded with a letter of agreement stating that the following materials are considered exempt from the Hazardous Materials Regulations:

HCl in water solution at concentrations of 0.4% by weight or less

$HgCl_2$ in water solutions at concentrations of 0.004% by weight or less

HNO_3 in water solutions at concentrations of 0.15% by weight or less

H_2SO_4 in water solutions at concentrations of 0.35% by weight or less

NaOH in water solutions at concentrations of 0.080% by weight or less

H_3PO_4 in water solutions at concentrations yielding a pH range between 4 and 2

Essential to this exemption is the agreement that all samples will be packaged in accordance with those procedures proposed by EPA that meet the requirements in 49 CFR 173.6 and 173.24. DOT also cautions EPA that "the person who offers such materials for transportation is responsible for ensuring that the concentrations are as represented."

5.0 REGULATION OF HAZARDOUS MATERIAL SAMPLES

5.1 The Hazardous Materials Table

The Hazardous Materials Table is an invaluable tool found in 49 CFR 172.101. It "designates the materials listed therein as hazardous materials for the purpose of transportation of those materials in commerce." The Table identifies the hazard class of each listed material, and specifies or references requirements in this subchapter pertaining to its packaging, labeling, and transportation. The sampler would do well to become familiar with this table and its wealth of information.

5.2 Classification of Samples of Unknown Composition

DOT regulations specify in 49 CFR 172.404 (L) that,

> "Except as provided in 173.21 and 173.86 of this subchapter, a material for which a reasonable doubt exists as to its class and labeling requirements, and for which a sample must be transported for laboratory analysis may be labeled according to the shipper's tentative class assignment based upon:
>
> 1. Defining criteria in this subchapter;
>
> 2. The hazard precedence prescribed in 173.2 of this subchapter; and
>
> 3. The shippers knowledge of the material."

Classification of materials having more than one hazard is discussed in 49 CFR 173.2 (a).

> "Except as provided in paragraph (b) of this section, a hazardous material, having more than one hazard as defined in the part must be classed according to the following order of hazards:
>
> (1) Radioactive material (except a limited quantity)
>
> (2) Poison A
>
> (3) Flammable gas
>
> (4) Non-flammable gas

(5) Flammable liquid

(6) Oxidizer

(7) Flammable solid

(8) Corrosive material (liquid)

(9) Poison B

(10) Corrosive material (solid)

(11) Irritating materials

(12) Combustible liquid (in containers having capacities exceeding 110 gallons)

(13) ORM-B

(14) ORM-A

(15) Combustible liquid (in containers having capacities of 110 gallons or less)

(16) ORM-E

(b) Exceptions. Paragraph (a) of this section does not apply to - (1). A material specifically identified in 172.101 of this subchapter."

The majority of samples collected by REAC will be liquids or solids from a variety of sources. To determine the proper hazard class, and thus, the proper shipping regulations, the shipper should begin at the top of the above list (a) and proceed downward, eliminating those hazard classes deemed non-applicable. The highest hazard class from which the sample cannot justifiable be eliminated becomes the hazard classification for that sample. In most cases, liquid and solid samples collected will not fit the definition of Radioactive material, Poison A, Flammable gas, Non-flammable gas or Oxidizer. This would leave Flammable liquid and Flammable solid as the two highest hazard classes under which the sample may be shipped.

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5.3 Dioxin

The packaging and shipment of dioxin is of special interest. Currently, dioxin (2,3,7,8-TCDD) is not listed in the Hazardous Materials Table or the Optional Hazardous Materials Table. However, the possible threat to human health and the environment posed by dioxins is well documented. It would not, therefore, be in the best interest of all those concerned to completely disregard DOT shipping regulations regarding Hazardous Materials. How then, do we determine the proper shipping name and regulations? In 49 CFR 172.402 (h) the DOT states that,

> "Except as provided...a material for which a reasonable doubt exists as to its class and labeling requirements, and for which a sample must be transported for laboratory analysis may be labeled according to the shipper's tentative class assignment based upon:
>
> (1) Defining criteria in this sub-chapter;
>
> (2) Hazard class precedence previously described, and
>
> (3) Shippers' knowledge of the material."

Based upon concurrence with the DOT, soil samples known to contain dioxins should be given the hazard class assignment of Poison B, with the proper shipping name "Poison B solid, n.o.s." and identification number UN 2811.

5.4 Package Markings

According to DOT regulations regarding package marking requirements (49 CFR 172.301 (a)),

> "each person who offers for transportation a hazardous material in a packaging having a rated capacity of 110 gallons or less shall mark the package with the proper shipping name and identification number (preceded by "UN" or "NA" as appropriate) assigned to the material in 172.101 or 172.102," (the Hazardous Material Table).

The markings required:

(1) Must be durable, in English and printed on or affixed to the surface of a package or on a label, tag, or sign.

(2) Must be displayed on a background of sharply contrasting color;

(3) Must be unobscured by labels or attachments; and

(4) Must be located away from any other marking (such as advertising) that could substantially reduce its effectiveness.

Additionally, packages having inside packaging containing liquid hazardous materials must be packed with the closures upward, and legibly marked "THIS SIDE UP" or "THIS END UP", as appropriate. When authorized packages (paint cans) are packaged in outside containers (coolers), the outside container must be marked "INSIDE PACKAGES COMPLY WITH PRESCRIBED REGULATIONS" (49 CFR 173.25). Any package designated ORM-E must be so marked on one side or end of the package immediately following or below the proper shipping name of the material. The ORM-E designation must be placed within a rectangle approximately 1/4 inch larger on each side than the designation.

5.5 Package Labeling

"Labels" refers to the DOT standard size, shape, color, and symbol labels corresponding to specific hazardous material classes. Specific labeling requirements for each hazard class are contained within the Hazardous Materials Table (49 CFR 172.101). When required, these labels must be affixed to the package near the proper shipping name. If an outside container is used, it also must be labeled as required for each material contained therein. Any package containing a material meeting the definition of multiple hazard classes must be labeled for each class as described in 49 CFR 172.402. No labels are required for materials classed as ORM-A,B,C,D, or E.

6.0 SAMPLE PACKAGING

6.1 Low Concentration or Environmental Samples

According to a letter of agreement between EPA and DOT, low concentration or environmental samples (typically water samples, both preserved and unpreserved) need only to be packaged to prevent breakage or leakage during transport. The recommended procedure for meeting this requirement is as follows:

1. Complete the information required on all documents, including chain of custody forms and seals.

2. Add preservatives as required for water samples.

3. Mark the sample level on each container with an indelible marker.

4. Tightly close container lids to prevent leakage. Tape the lids for added protection. Use custody seals on lids in regions requiring such.

5. Using fiberglass or duct tape, seal the drain plug at the bottom of the cooler to prevent leakage due to broken containers or melting ice. The cooler may also be lined with a plastic bag before packing samples to prevent leakage. Seal the bag after packing samples.

6. Line the bottom of the cooler with a layer of inert absorbent cushioning material. Vermiculite is recommended.

7. Seal each sample container in an individual plastic bag, and place upright in the cooler.

8. If samples must be cooled, loosely place small amount of ice in sealed plastic bags around the samples.

9. Fill the remaining space in the cooler with vermiculite.

10. Documentation accompanying the samples should be placed in a sealed plastic bag and taped to the inside lid of the cooler.

11. Close and latch the lid of the cooler.

12. Affix two chain of custody seals to the cooler in such a manner that they must be removed or broken to open the cooler. One seal should be affixed to the front of the cooler and the second to the rear of the cooler, diagonally opposite the first.

13. Wrap fiberglass-reinforced tape around each end of the cooler several times so that the custody seals are covered by the tape. Do not wrap the tape so thickly that the seals become unreadable through the tape.

14. Mark the outside of the cooler with the following information: name and address of receiving laboratory, name of contact at laboratory, shipper's name and address, and labels on all four sides with arrows indicating "This Way Up".

6.2 Hazardous Material Samples

If the hazardous material is of known content, package, label, and ship according to instructions in 49 CRF 172.101.

If the hazardous material is of unknown content, part 172.402(h) of 49 CFR allows "...a material for which a reasonable doubt exists as to its class and labeling requirements, and for which a sample must be transported for laboratory analysis may be labeled according to the shipper's tentative class assignment based upon...(2) the hazard precedence prescribed in 173.2 of 49 CFR." Typically we will ship samples of this type as either a Flammable liquid or Flammable solid (see Table 173.2 attached).

1. Perform steps 1-6 as described for environmental samples.

2. Line a clean half-gallon paint can with 1-2 inches of vermiculite.

3. Seal the sample jar in a plastic bag and place upright in the paint can. Use only one sample per plastic bag per paint can.

4. Fill the paint can with vermiculite and seal the lid firmly with fiberglass or duct tape.

5. Place a "This Way Up" label on the can with arrows indicating the position of the jars.

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6. Upon selection of the proper Hazard Class (see Section 7.2) and proper shipping name, label the can with the proper DOT Hazard Class label and mark the can with the proper DOT shipping name.

7. Place the sample cans upright in the cooler and fill the remaining space with vermiculite.

8. Complete the packaging as described in steps 10-14 of the environmental sample procedure.

9. Mark and label the cooler with the proper DOT shipping names and DOT hazard class labels. The cooler should also be marked "Inside containers comply with prescribed specifications." If the compounds being shipped are either forbidden on or exceed allowable quantities for passenger-carrying aircraft, label the cooler "Cargo Aircraft Only."

10. Complete and sign shipper's certification.

6.3 High Hazard Samples

In most cases, samples collected during REAC operations will be packaged as described as above for either environmental or hazardous material samples. There is, however, the possibility that samples may be collected from unopened and unmarked containers. In that case, it may not be possible to exclude the classification of these samples as "Poison A", "Flammable Gas", "Non-Flammable Gas", or "Radioactive". Consultation of the Hazardous Materials Table will reference the sampler to the location of the specific requirements that must be followed in order to remain in compliance with DOT. Of special note is the fact that any shipment classified as "Poison A" cannot be shipped on either passenger-carrying or cargo-only aircraft, no matter what the volume in question. Poison A material can only be shipped via ground transportation or government aircraft. (See following Table 2004A for packaging of Radioactive and Poison A materials).

HAZARDOUS MATERIAL CLASSIFICATIONS
(49 CFR 173.2)

1. RADIOACTIVE MATERIAL
2. POISON A
3. FLAMMABLE GAS
4. NONFLAMMABLE GAS
5. FLAMMABLE LIQUID
6. OXIDIZER
7. FLAMMABLE SOLID
8. CORROSIVE MATERIAL (liquid)
9. POISON B
10. CORROSIVE MATERIAL (solid)
11. IRRITATING MATERIAL
12. COMBUSTIBLE LIQUID (more than 110 gals)
13. ORM-B
14. ORM-A
15. COMBUSTIBLE LIQUID (110 gals or less)
16. ORM-E

7.0 SAMPLE SHIPMENT

Once the samples are properly labeled and packaged, the appropriate shipping documents must be prepared and submitted to the carrier with the samples. This generally involves the preparation of an airbill and shipper's certification for restricted articles. Each contract carrier typically supplies these forms. Although different carriers' documents will vary in format, they generally request the same information.

7.1 Airbills

The airbill is simply a shipping paper identifying the destination and return address for the shipment, and providing a description of the shipment and delivery instructions. Airbills from several contract carriers with preprinted shipper or recipient information are available at the office in Edison. Complete the forms as follows; (print or type only:)

1. Name of the shipper and office address, including Zip code.

2. Date of shipment and recipient's office address.

3. Check the mode of payment. In most cases, this will be Weston. Use the REAC charge number where requested to provide reference numbers. This will simplify inventory and cost tracking.

4. In most cases, the type of service requested will be "Priority I". When shipping on Fridays, verify in advance the laboratory's ability to handle Saturday delivery.

5. The carrier will then complete the airbill. Make sure the information provided by the carrier does not conflict with the chain of custody, on time and date of shipment.

7.2 Shipper's Certification For Restricted Articles

The shipper's certification for restricted articles is a signed statement indicating the type and quantity of hazardous materials in a shipment, and certifying that the shipment conforms to all applicable regulations. These forms are available from the contract carrier. This form should be used whenever shipping medium or high-concentration samples. Printing or typing only will be accepted.

TABLE 2004A: PACKAGING OF RADIOACTIVE MATERIALS (Limited Quantity)

According to 49 CFR 173.421..."Radioactive materials whose activity per package does not exceed the limits specified in 173.423 are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements...if:

(a) the materials are packaged in strong, tight packages that will not leak...
(b) the radiation level...on the external surface of the package does not exceed 0.5 millirem/hour.
(c) the outside of the inner packaging or if there is no inner packaging, the outside of the package itself bears the marking "Radioactive".

49 CFR.421-1 requires that radioactive material instruments or limited quantity material "must be certified as being acceptable for transportation." A notice must be enclosed in the package with the name of the person the package is being shipped to, and the statement, "This package conforms to the conditions and limitations specified in...

...49 CFR 173.421 for excepted radioactive material, limited quantity,n.o.s.,UN2910.

...49 CFR 173.422 for excepted radioactive material, instruments and articles, UN2911.

...49 CFR 173.424 for excepted radioactive material, articles manufactured from natural or depleted uranium or natural thorium, UN2909."

TABLE 2004.A PACKAGING OF POISON A MATERIALS

Packaging:

- Collect all samples in polyethylene or glass containers which will fit inside a D.O.T. specifications #3A1800 or #3AA1800 metal cylinder.
- Seal the sample container and lower into metal cylinder, partially filled with vermiculite (only one sample per metal cylinder).
- Replace the valve using teflon tape, torque to 250 ft/lbs (for 1 in. opening), and replace valve protector.
- Place the metal cylinders in a cooler.

Labeling:

On cylinders:	"Poisonous Liquid, n.o.s. NA 1955"
	"Poisonous Gas, n.o.s. NA 1955"
	Lab name and address
	DOT label "Poisonous Gas" (for liquids and gases)
Outside containers or coolers:	"Laboratory Sample" "Inside Packages Comply With Prescribed Specifications"
	"This End Up"

Complete chain-of-custody, place in sealed polyethylene bag and tape to inside lid of shipping container.

NOTE: Retain a copy for records.

Complete the carrier provided bill of lading and sign certification statement.

Transportation: Hazardous Substance samples classified as Poison A may be transported by ground transport or government-owned aircraft only.

7.2 Shipper's Certification For Restricted Articles

The shipper's certification for restricted articles is a signed statement indicating the type and quantity of hazardous materials in a shipment, and certifying that the shipment conforms to all applicable regulations. These forms are available from the contract carrier. This form should be used whenever shipping medium or high-concentration samples. Printing or typing only will be accepted.

1. "No. of Packages" - Indicate the number of packages (coolers) being shipped on that airbill. If more than one hazard class is being shipped, indicate the total for each class.

2. "Proper Shipping Name" - Enter the proper shipping name for the material exactly as written in the Hazardous Materials Table #49 CFR 172.101). This will typically be "Flammable Liquid, N.O.S.", or "Flammable Solid, N.O.S.".

3. "Classification" - Enter the proper hazard class exactly as listed in the Hazardous Materials Table for that specific shipping name.

4. "Identification Number" - Enter the identification number exactly as listed in the Hazardous Materials Table for that specific shipping name.

5. "Net Quantity Per Package" - Print the net quantity of the hazardous material being shipped. Multiply the number of samples by the volume or weight of each to obtain this figure. If the net quantity of "Flammable Liquid" exceeds 32 ounces, the package must be shipped via "cargo aircraft only" and that phrase must be printed on the description section of the shipper's certification. A net quantity of "Flammable Solid" exceeding 25 pounds must also be shipped via "cargo aircraft only," with the phrase "cargo aircraft only" printed on the description section of the shipper's certification. If the quantity of hazardous materials is allowable, print "Limited Quantity- Samples for Laboratory Analysis" on the bottom of the description section. Quantities below the limits set forth in the Hazardous Materials Table may be shipped via passenger-carrying aircraft.

6. Print the shippers' name, title, and phone number in the space provided. The shipper must then sign the certification in the space provided.

   (Refer to attached example shipping pages for a summary of this information).

7.3 Shippers' Liability

The information provided in this section can only provide general guidance. For verification of this information, the shipper should refer to the DOT regulations (49 CFR 170-178), or contact the DOT directly at 202-426-2075 or 202-366-4483. Most contract carriers have personnel well trained in the shipment of hazardous materials. Of utmost importance, however, is that the shipper realizes that by signing the shipper's certification, he assumes full responsibility for the packaging, labeling, marking, and classification of the samples.

It is important to note that many preservatives are classified as hazardous materials, and must be handled as such. In particular, nitric acid is forbidden aboard passenger-carrying aircraft and aircraft as well. Consult the Hazardous Materials Table for specific requirements regarding specific preservative.

It is also advised that the shipper contact the contract carrier prior to shipment, as many carriers impose additional requirements, such as shipping hazardous materials only on certain days of the week or specifying packing materials to be used.

8.0 REAC S&A SECTION

The REAC S&A section is an integral part of any REAC sampling effort. Their function, as it applies here, is to coordinate the selection of a contract laboratory, perform a QA/QC review of the analytical data, present the data in report form, and maintain contact between O&A and the selected laboratory. As soon as a Task Leader is assigned to a project, he/she should review the work assignment and interface with the ERB Task Monitor to determine preliminary analytical needs for that project. Marian Murphy should then be notified of these needs. The information to Marian should include the number of types of samples expected, analyses requested and conditions imposed by ERB, and anticipated arrival of the samples at the laboratory. Shortly thereafter, Marian will inform the Task Leader of the selected laboratory, and provide the information needed to perform the shipment. If the field conditions require revision of the original sampling plan, call Marian immediately and make him aware of the changes. The importance of good communication between O&A and S&A cannot be over emphasized. Projected costs for analytical services should be included in the Work Plan.

EXAMPLE SHIPPING PAPERS - SECTION 2004

TO BE INCLUDED

9.0 APPLICABILITY

The standard operating procedures set forth herein will be applied by all REAC personnel whenever packaging or shipping hazardous or nonhazardous materials samples.

1.0 OBJECTIVE

These procedures will ensure that samples collected in the field are accurate representatives of actual field conditions and have not been cross-contaminated during sampling activities.

2.0 DESCRIPTION OF METHODS

2.1 Field Blanks

Field blanks are sample containers filled with deionized water from a noncontaminated source, such as an analytical laboratory. They are used to determine if the sampling procedures promote contamination. The field blank is obtained prior to the start of sampling activities and is carried throughout the sampling effort. After the sampling is completed the field blanks are shipped with the samples to the analytical laboratory where they are analyzed for the same parameters as the samples.

Careless sample handling, improper decontamination, and nonconformance with Standard Operating Procedures can cause cross-contamination, nonreproducible results, and samples that do not accurately represent the site. The blanks can determine if any of these nonconformances occurred and to what extent they have tainted the sampled media.

Trip blanks are only required when low detection limits are required as for environmental samples. Highly concentrated samples such as drum, tank, lagoon samples do not require low detection limits and therefore, do not require trip blanks.

2.2 Equipment Blanks

Equipment blanks consist of deionized water that has been run over the surfaces of sampling equipment after the final deionized water rinse. The use of equipment blanks ensures that the sampling equipment has been thoroughly decontaminated prior to reuse. Equipment blanks are analyzed for the same parameters as the sampled media.

Equipment blanks are only required when the sampling team suspects the presence of contaminants that require very low detection limits such as 2,3,7,8-tetrachlorodibenzo-p-dioxin.

Equipment that is used on sampling events that require low detection limits should be decontaminated prior to the start of any sampling activity to insure that the equipment is free from contamination. Equipment blanks must be taken each time a piece of sampling equipment is decontaminated with the intent of reusing it.

Equipment blanks are part of the QA/QC plan and are used to reinforce data submitted as evidentiary information.

2.3 Duplicate Samples

A duplicate sample is one which has been taken from or near an area already sampled in order to determine the representativeness of the selected sampling points.

One out of every ten samples taken must have a duplicate sample submitted for analysis. At least one duplicate sample will be taken during operations that require fewer than ten samples.

Duplicate samples are not required for high-hazard samples unless it is suspected that additional analysis will be requested after the sampling event. In this case, duplicated samples will be taken with each sample.

Duplication samples enable the analytical lab to repeat sample analysis as a QA/QC check on the analytical methods and procedures.

3.0 APPLICABILITY

These QA/QC Sample Procedures will be incorporated into field sampling events that require quantitative measurement of analytical parameters.

4.0 LIMITATIONS

Quality Control of the field samples can only be assured if these procedures are used during sampling events. The procedures outlined in this text must be followed completely to generate quality data.

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* These sections affected by Revision 2.0

SUPERCEDES: SOP#2006, REVISION: 1.0, DATE: 08/21/89

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide a description of the methods used for preventing or reducing cross-contamination and general guidelines for designing and selecting decontamination procedures at a hazardous waste site. The decontamination procedures chosen will prevent or minimize the introduction or cross-contamination of contaminants in sampled media and samples, and will protect the health and safety of site personnel.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants that have accumulated on personnel and equipment insures protection of personnel from permeating substances, reduces or eliminates transfer of contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample contamination.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high pressure water cleaning. These methods should be followed by a wash/rinse process using appropriate cleaning solutions. A general protocol for cleaning is as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Total air dry
9. Distilled/deionized water rinse

Selection of the solvent for use in the decontamination process is based on the contaminants present at the site. Use of a solvent is required when organic contamination is present on-site. Typical solvents used for removal of organic contamination include acetone, hexane, or water. The acid rinse step is required if metals are present on-site. If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. Care should be employed when selecting the solvent to ensure that the decontamination solvent is not a contaminant of concern at the site.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this Standard Operating Procedure (SOP).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

1. The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free.

2. The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal water treatment system.

3. Acids and solvents utilized in the decontamination sequence raise health and safety and shipping concerns.

4. The site specific work plan must address what to do with the spent decontamination solutions.

5. Several procedures can be established to minimize contact with waste and the potential for contamination. For example:

   - o Stress work practices that minimize contact with hazardous substances.
   - o Remote sampling, handling, and container-opening techniques may be utilized.
   - o Covering monitoring and sampling equipment with plastic or other protective material will minimize contamination.
   - o Use of disposable outer garments and disposable sampling equipment may be appropriate.

5.0 EQUIPMENT/APPARATUS

The following standard materials and equipment are required for decontamination activities:

- Appropriate personal protective clothing
- Non-phosphate detergent
- Selected solvents
- Long-handled brushes
- Drop cloths/plastic sheeting
- Trash container
- Paper towels
- Galvanized tubs or buckets
- Tap water
- Distilled/deionized water
- Metal/plastic container for storage and disposal of contaminated wash solutions
- Pressurized sprayers, H_2O

- Sprayers, solvents
- Trash bags
- Aluminum foil
- Safety glasses or splash shield
- Emergency eyewash bottle

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. In general, the following solvents are utilized for decontamination purposes:

- o 10% nitric acid[1]
- o Acetone (pesticide grade)[2]
- o Hexane (pesticide grade)[2]
- o Methanol

[1] - Only if sample is to be analyzed for trace metals.
[2] - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- o The number, location, and layout of decontamination stations.
- o The decontamination equipment needed.
- o The appropriate decontamination methods.
- o Methods for disposal of contaminated clothing, equipment, and solutions.

7.1 Decontamination Methods

All personnel, samples, and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to them. Various decontamination methods will either physically remove contaminants, inactivate contaminants by disinfection or sterilization, or do both.

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods.

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The following abrasive methods are available:

1. Mechanical

   Mechanical methods of decontamination include using brushes of metal or nylon. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, and degree of brush contact.

2. Air Blasting

   Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. However, disadvantages of this method are its inability to control the amount of material removed and the large amount of waste generated.

3. Wet Blasting

   Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using very fine abrasives, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, less of the equipment surface is removed using non-abrasive methods.

1. High-Pressure Water

   This method consists of a high-pressure pump, an operator controlled directional nozzle, and high pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) which relates to flow rates of 20 to 140 liters per minute.

2. Ultra-High-Pressure Water

   This system produces a water jet that is pressured from 1,000 to 4,000 atm. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 m/sec (1,000 atm) to 900 m/sec (4,000 atm). Additives can be used to enhance the cleaning action.

3. Rinsing

   Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

4. Disinfection/Sterilization

   Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Cleaning Procedures

The following steps for equipment decontamination should be followed for general field sampling activities.

1. Physical removal (as specified in Section 7.1)
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Total air dry
9. Distilled/deionized water rinse

Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. After each solvent rinse, the equipment should be air dried and rinsed with distilled/deionized water.

Solvent rinses are not necessarily required when organics are not a contaminant of concern and may be eleminated from the sequence specified above. Similarly, an acid rinse is not necessarily required if analysis does not include inorganics.

Sampling equipment that requires the use of a plastic tubing should be disassembled and the tubing replaced with clean tubing before commencement of sampling between sampling locations.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There is one specific type of quality control sample associated with the field decontamination process, a rinsate blank. This sample will provide information on the effectiveness of the decontamination process employed in the field. In addition, a rinsate blank provides an additional check on possible sources of contamination from ambient air and sample transportation to the laboratory.

A rinsate blank consists of a sample of analyte free water which is passed over and through a field decontaminated sampling device and placed in a clean sample container. This should be performed in the most contaminated area to attempt to simulate a worst case condition regarding ambient air contributions to sample contamination.

Rinsate blanks should be collected at a rate of one per parameter per 20 even if samples are not shipped that day. Rinsate blanks are not required if dedicated sampling equipment is used.

The rinsate blank provides a mechanism of control on sample handling, storage and shipment. It is also indicative of ambient conditions or equipment conditions that may affect the quality of the samples.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow USEPA/OSHA and corporate health and safety procedure.

Decontamination can pose hazards under certain circumstances even though performed to protect health and safety. Hazardous substances may be incompatible with decontamination methods. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Decontamination methods may be incompatible with clothing or equipment; some solvents can permeate or degrade protective clothing. Also, decontamination solutions may pose a direct health hazard to workers if inhaled, or come in contact with the skin, or may be flammable.

The decontamination solutions must be determined to be compatible before use. Any method that permeates, degrades, or damages personnel protective equipment should not be used. If decontamination methods do pose a direct health hazard, measures should be taken to protect personnel or modified to eliminate the hazard.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

TABLE
SOP #2006
September, 1990

TABLE 1. Soluble Contaminants and Recommended Solvent Rinse

SOLVENT	SOLUBLE CONTAMINANTS
Water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Basic (caustic) compounds Amines Hydrazines
Dilute Bases For example: - detergent - soap	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents[1] For example: - alcohols - ethers - ketones - aromatics - straight-chain alkanes (e.g., hexane) - common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)

[1] - WARNING: **Some organic solvents can permeate and/or degrade the protective clothing.**

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1.0 SCOPE AND APPLICATION

This document describes the procedures for the collection of representative soil samples. Analysis of soil samples may determine whether concentrations of specific soil pollutants exceed established threshold action levels, or if the concentrations of soil pollutants present a risk to public health, welfare, or the environment.

Included in this discussion are procedures for obtaining representative samples, Quality Assurance/Quality Control measures; proper documentation of sampling activities, and recommendations for personal safety.

2.0 METHOD SUMMARY

Soil samples may be recovered using a variety of methods and equipment. These are dependent on the depth of the desired sample; the type of sample required (disturbed vs. undisturbed); and the soil type.

Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, a power auger, or, if a test pit is required, a backhoe.

All sampling devices should be laboratory cleaned, preferably by the laboratory performing the analysis, using pesticide grade acetone (assuming that acetone is not a target compound) or methanol, then wrapped in cleaned and autoclaved aluminum foil, and custody sealed for identification. The sampler should remain in this wrapping until it is needed. Each sampler should be used for one sample only. However, dedicated samplers may be impractical if there are a large number of soil samples required. In this case, samplers should be cleaned in the field using the decontamination procedure in EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The chemical preservation of solids is not generally recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time.

Soil samples should be handled according to the procedures described in EPA/REAC SOP# 2003, Sample Storage, Preservation and Shipping by Parameter or Group of Parameters.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with soil sampling. These include cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and bottles. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, the disturbance of the matrix resulting in compaction of the sample and inadequate homogenizing the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT

Soil Sampling Equipment List

Sampling Plan
Maps/Plot Plan
Safety equipment, as specified in the Health and Safety Plan
Compass
Tape measure
Survey stakes or flags
Camera

Stainless steel bucket or bowl
One-quart mason jars w/Teflon liners
Plastic bags for samples and sample jars
Logbook
Labels
Chain of Custody forms
Site Description forms
Cooler(s)
Ice
Decontamination supplies/equipment

Canvas or plastic sheet
Spade or shovel
Spatula
Scoop
Trowel
Continuous flight auger
Bucket auger
Extension rods

T-Handle
Sampling trier
Vehimeyer soil sampler outfit
- Tubes
- Points
- Drive head
- Drop hammer
- Puller jack and grip

Backhoe

6.0 REAGENTS

This procedure does not require the use of reagents; except for decontamination of equipment, as required. Refer to EPA/REAC SOP# 2006 Equipment Decontamination Procedures and site specific work plan for appropriate solvents.

7.0 PROCEDURES

7.1 Office Preparation

1. The preparation of a Health and Safety Plan is required prior to any sampling. The plan must be approved and signed by the Corporate Health and Safety Officer or his/her designee.
2. Prepare a sampling plan in accordance with EPA/REAC SOP# 2014, Quality Assurance Work Plan Preparation. Review available background information (i.e. topographic maps, soil survey maps, geologic survey maps, other site reports, etc.) to determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
3. Obtain necessary sampling and monitoring equipment (see Section 5). Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Contact delivery service to confirm ability to ship all equipment and samples. Determine if shipping restrictions exist.
5. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.

7.2 Field Preparation

1. Identify local suppliers of sampling expendables (e.g., ice, plastic bags) and overnight delivery services (e.g., Federal Express, Emery, Purolator).
2. Decontaminate or pre-clean all equipment before soil sampling, as described in EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination, or as deemed necessary.

3. A general site survey should be performed prior to site entry in accordance with the Health and Safety Plan.
4. Identify and stake all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be utility-cleared by the property owner prior to soil sampling.

7.3 Sample Collection

A. Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, and scoops. The surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop can be used to collect the sample.

This method can be used in most soil types but is limited to sampling near surface areas. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sampling technician. The use of a flat, pointed mason trowel to cut a block of the desired soil can be helpful when undisturbed profiles are required. A stainless steel scoop, lab spoon, or plastic spoon will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect the soil samples:

1. Carefully remove the top layer of soil to the desired sample depth with a precleaned spade.

2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which comes in contact with the shovel.

3. Transfer sample into an appropriate sample container with a stainless steel or plastic lab spoon, or equivalent. If composite samples are to be collected, place the soil sample in a stainless steel or plastic bucket, and mix thoroughly to obtain a homogeneous sample representative of the entire sampling interval. Then, place soil sample into labeled containers.

3.3 Sampling Documentation

All sediment samples shall be documented in accordance with EPA/REAC SOP# 2002, Sample Documentation.

3.3.1 Label

The sample label will be filled out prior to collecting the sample and will contain the following information:

1. Site name or identification
2. Sample location and identifier
3. Date of collection, in day, month, year format (e.g., 03 JAN 88 for January 3, 1988)
4. Time of sample collection using a 24 hour clock in format hours and minutes
5. Sample depth interval. Units used for depths should be in meters and centimeters
6. Preservatives used, if any
7. Analysis required
8. Sampling personnel
9. Comments and other relevant observations (e.g., color, odor, sample technique)

3.3.2 Logbook

1. A bound field notebook will be maintained by field personnel to record daily activities, including sample collection and tracking information. Entries will be made in waterproof ink. A separate entry will be made for each sample collected.

2. Entries will include the following information from the sample label plus a complete physical description of the sediment sample, including depth of overlaying aqueous layer, texture, color, consistency, moisture content, cementation, and structure.

3.3.3 Chain of Custody

The chain-of-custody form is used to document the types and numbers of sediment samples collected and logged. Refer to EPA/REAC SOP# 2002, Sample Documentation for directions on filling out this form.

3.4 Sample Handling

Transfer sediment from sampling implement to an appropriate sample container using a stainless steel or plastic lab spoon or equivalent. If composite samples are collected, place the sediment sample in a stainless steel, plastic or other appropriate composition (e.g.: Teflon) bucket, and mix thoroughly to obtain a homogeneous sample representative of the entire sampling interval. Then place soil sample into labeled containers.

Samples for volatile organic analysis will be collected directly from the bucket, before mixing the sample, to minimize volatilization of contaminants.

3.5 Decontamination

All sampling devices should be cleaned, preferably using pesticide grade acetone (assuming that the acetone is not a target compound) or methanol; then wrapped in cleaned and autoclaved aluminum foil. The sampler should remain in this wrapping until it is needed. Each sampler should be used for only one sample. Dedicated samplers for sediment samples may be impractical due to the large number of sediment samples which may be required. In this case, samplers should be cleaned in the field using the decontamination procedure described in EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Substrate particle size and organic matter content are directly related to water velocity and flow characteristics of a waterbody. Contaminants are more likely to be concentrated in sediments typified by fine particle size and a high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content, do not typically concentrate pollutants and are found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results.

The type of environment, with respect to flow and water velocity, will be a function of the study objectives, and should be specified in the sampling plan.

5.0 EQUIPMENT/APPARATUS

Sampling Plan
Maps/Plot Plan
Safety equipment as specified in Health and Safety Plan
Compass

Tape measure
Survey stakes, flags, or buoys
Camera and film
Stainless steel, plastic, or other appropriate composition (e.g.: Teflon) bucket
One-quart mason jars w/Teflon lined lids
Eight-ounce wide mouth jars with Teflon lined lids
Four-ounce wide mouth jars with Teflon lined lids
Ziploc® plastic bags for samples, and sample jars
Logbook
Labels
Chain of Custody Forms
Site Description Forms
Cooler(s)
Ice
Decontamination supplies/equipment
Spade or shovel
Spatula
Scoop
Trowel
Bucket auger
Thin wall auger
Extension rods
T-handle
Sampling trier
Sediment coring device
- tubes
- points
- drive head
- drop hammer
- eggshell check valve devices
- acetate cores

Ponar dredge
Ekman dredge
Nylon rope

6.0 REAGENTS

Pesticide grade acetone
Methanol
Five-percent nitric acid
Laboratory detergent (liquid)
Distilled water
Potable water

7.0 PROCEDURES

7.1 Preparation

7.1.1 Office

A. The preparation of a Health and Safety Plan is required prior to any sampling. The plan must be approved and signed by the REAC Health and Safety Officer, or his designee.
B. Prepare sampling plan in accordance with EPA/REAC SOP# 2014, Quality Assurance Work Plan Preparation. Review available background information (e.g.: topographic maps, bathymetric maps, geologic survey maps, other site reports) to determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
C. Obtain necessary sampling and monitoring equipment (see Section 5.0). Decontaminate or preclean equipment, and ensure that it is in working order. If equipment will not be transported to the site by the sampling team, it must be shipped to the site by a delivery service.
D. Contact delivery service to confirm ability to ship all equipment and samples and determine if any shipping restrictions apply.
E. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.

7.1.2 Field

A. Identify overnight delivery services (e.g., Federal Express, Emery, Purolator) and local suppliers of sampling expendables (e.g., ice, plastic bags).
B. Decontaminate or preclean all equipment before sediment sampling, as described in EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination, or as deemed necessary.
C. Perform a general site survey prior to site entry in accordance with the Health and Safety Plan.
D. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, and extent and nature of contaminant should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

E. Selection of a sample device is most often contingent upon the following factors:

a. Depth of water at the sampling location
b. Physical characteristics of the medium to be sampled.

7.2 Sample Collection

7.2.1 Sampling Surface Sediments with Trowels or Scoops from Beneath a Shallow Aqueous Layer

Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, and scoops. The surface material can be removed to the required depth; then a stainless steel or plastic scoop should be used to collect the sample.

This method can be used to collect consolidated sediments but is limited somewhat by the depth of the aqueous layer. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sampling technician. A stainless steel or plastic scoop or lab spoon will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as plotting trowels.

The following procedure will be used to collect the sediment samples:

1. Using a precleaned stainless steel scoop or trowel, remove the desired thickness of sediment from the sampling area.
2. Transfer sample into an appropriate sample or homogenization container.

7.2.2 Sampling Surface Sediments with a Thin Wall Tube Auger from Beneath a Shallow Aqueous Layer

This system consists of an auger, a series of extensions and a "T" handle. The auger is driven into the sediment and used to extract a core. A sample of the core is taken from the appropriate depth.

The following procedure will be used for collecting sediment with a thin walled auger:

1. Insert the auger into the material to be sampled at a 0^{o} to 45^{o} angle from horizontal. This orientation minimizes the spillage of sample from the sampler. Extraction of samples may require tilting of the containers.
2. Rotate the trier once or twice to cut a core of material.
3. Slowly withdraw the trier, making sure that the slot is facing upward.
4. An acetate core may be inserted into the auger prior to sampling if characteristics of the sediments or waterbody warrant. By using this technique, an intact core can be extracted.
5. Transfer sample into an appropriate sample or homogenization container.

7.2.3 Sampling Deep Sediments with Augers and Thin Wall Tube Samplers from Beneath a Shallow Aqueous Layer

This system consists of an auger, a series of extensions and a "T" handle and a thin-wall tube sampler. The auger is used to bore a hole to a desired sampling depth and then withdrawn. The auger tip is then replaced with a tube core sampler, lowered down the borehole, and driven into the sediment at the completion depth. The core is then withdrawn and the sample collected. This method can be used to collect consolidated sediments, but is somewhat limited by the depth of the aqueous layer.

Several augers are available which include bucket type, and posthole augers. Bucket type are better for direct sample recovery and are fast, and provide a large volume of sample. Posthole augers have limited utility for sample collection as they are designed more for their ability to cut through fibrous, rooted, swampy area.

The following procedure will be used for collecting sediment samples with the hand auger:

1. Attach the auger bit to a drill rod extension, then attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (e.g.: twigs, rocks, litter).
3. Begin augering, periodically removing any accumulated sediment from the auger bucket.
4. After reaching desired depth, slowly and carefully remove auger from boring. When sampling directly from the auger, collect sample after auger is removed from boring and proceed to Step 10.

5. Remove auger tip from drill rods and replace with a precleaned thin-wall tube sampler. Install proper cutting tip.
6. Carefully lower tube sampler down borehole. Gradually force tube sampler into sediment. Care should be taken to avoid scraping the borehole sides. Hammering of the drill rods to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse.
7. Remove tube sampler and unscrew drill rods.
8. Remove cutting tip and remove core from device.
9. Discard top of core (approximately 1 inch), as this represents material collected by the tube sampler before penetration of the layer in question.
10. Transfer sample into an appropriate sample or homogenization container.

7.2.4 Sampling Surface Sediments from Beneath a Deep Aqueous Layer

This technique consists of a sampling mechanism lowered to the sediment by use of a rope, cable, or extended handle. The mechanism is triggered, and the device entraps sediment in spring loaded jaws, or within lever operated jaws.

7.2.4.1 The following procedure will be used for collecting sediments with an Ekman Dredge (Figure 3):

1. Attach a sturdy nylon or stainless steel cable to the hook provided, or secure the extended handle to the bracket with machine bolts.
2. Arrange the Ekman dredge sampler so that the jaws are in the open position and trip cables are positioned over the release studs.
3. Lower the sampler to a point just above the sediment surface.
4. Drop the sampler sharply onto the sediment.
5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the bottom on the upper end of the extended handle.
6. Raise the sampler and slowly decant any free liquid through the top of the sampler.
7. Open the dredge and transfer the sediment into a stainless steel or plastic bucket. Continue to collect additional sediment until sufficient material has been secured. Thoroughly mix sediment to obtain a homogeneous sample, and then transfer to the appropriate sample container.

8. Samples for volatile organic analysis will be collected directly from the bucket before mixing the sample to minimize volatilization of contaminants.

7.2.4.2 The following procedures will be used for collecting sediments with a Ponar Dredge (Figure 4):

1. Attach a sturdy nylon or steel cable to the hook provided on top of the dredge.
2. Arrange the Ponar dredge sampler in the open position, setting the trip bar so the sampler remains open when lifted from the top.
3. Slowly lower the sampler to a point just above the sediment.
4. Drop the sampler sharply into the sediment while jerking up on the line, thus releasing the trip bar and closing the dredge.
5. Raise the sampler to the surface and slowly decant any free liquid through the screens on top of the dredge.
6. Open the dredge and transfer the sediment to a stainless steel or plastic bucket. Continue to collect additional sediment until sufficient material has been gained. Thoroughly, mix sediment to obtain a homogeneous sample, and then transfer to the appropriate sample container.
7. Samples for volatile organic analysis will be collected directly from the bucket before mixing the sample to minimize volatilization of contaminants.

7.2.5 Sampling Subsurface Sediments from Beneath a Deep Aqueous Layer

This methodology describes the use of a core sampler (Figure 5) used to collect subsurface sediments. It consists of a coring device, handle, and acetate core utilized in the following procedure:

1. Assemble the coring device by inserting the acetate core into the sampling tube.
2. Insert the "egg shell" check value mechanisms into the tip of the sampling tube with the convex surface positioned inside the acetate core.
3. Screw the coring point onto the tip of the sampling tube.
4. Screw the handle onto the upper end of the sampling tube and add extension as needed.

4. Samples for volatile organic analysis will be collected directly from the bottom of the hole before mixing the sample to minimize volatilization of contaminants.

5. Check that the Teflon liner is present in the cap, if required. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time. Refer to EPA/REAC SOP# 2003, Sample Storage, Preservation, and Shipping by Parameter or Group of Parameters.

6. Check to be sure that enough sample has been collected for the desired analysis, as specified in Sampling Plan.

7. Decontaminate equipment between samples, according to EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination.

8. Fill in the hole and replace grass turf if necessary.

9. Collect QA/QC samples as specified, according to the QAWP.

10. Collect background samples if specified in the sampling plan (work plan) using the procedure outlined in steps 1-7 above.

B. Sampling at depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, a series of extensions, a "T" handle, and a thin-wall tube sampler (Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The auger tip is then replaced with a tube core sampler, lowered down the borehole, and driven into the soil at the completion depth. The core is then withdrawn and the sample collected.

Several augers are available. These include: bucket type, continuous flight (screw), and posthole augers. Bucket type are better for direct sample recovery as they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly off the flights, which are usually at five (5) feet intervals. The continuous flight augers are satisfactory for use when a composite of the complete soil column is desired. Posthole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil.

The following procedure will be used for collecting soil samples with the hand auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris (e.g.: twigs, rocks, litter). It may be advisable to remove the first 3 to 6 inches of surface soil for an area approximately 6 inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a canvas or plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from boring. When sampling directly from the auger, collect sample after the auger is removed from boring and proceed to Step 10.

5. Remove auger tip from drill rods and replace with a pre-cleaned thin-wall tube sampler. Install proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into soil. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler, and unscrew the drill rods.

8. Remove the cutting tip and the core from device.

9. Discard the top of the core (approximately 1 inch), as this represents material collected before penetration of the layer in question. Place the remaining core into the sample container.

10. If required, ensure that a Teflon liner is present in the cap. Secure the cap tightly onto the sample container and place on ice immediately after collection. Freezing may be required. Consult EPA/REAC SOP# 2003, Sample Storage, Preservation, and Shipping by Parameter or Groups of Parameters.

11. Carefully and clearly label the container with the appropriate sample tag addressing all the categories or parameters listed in EPA/REAC SOP# 2002, Sample Documentation.

12. Use the Chain-of-Custody Form to document the types and numbers of soil samples collected and logged.

13. Record the time and date of sample collection as well as a description of the sample in the field logbook.

14. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.

15. Abandon the hole according to applicable State regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

16. Decontaminate the sampling equipment as per EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination.

C. Sampling at Depth with a Trier

1. Insert the trier (Appendix B) into the material to be sampled at a 0^0 to 45^0 angle from horizontal. This orientation minimizes the spillage of sample. Extraction of samples might require tilting of the containers.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. Transfer the sample into a suitable container with the aid of a spatula and/or brush.

5. If required, ensure that a Teflon liner is present in the cap. Secure the cap tightly onto the sample container. Samples are handled in accordance with EPA/REAC SOP# 2003, Sample Storage, Preservation, and Shipping by Parameter or Groups of Parameters.

6. Carefully and clearly label the container with the appropriate sample tag addressing all the categories or parameters listed in EPA/REAC SOP# 2002, Sample Documentation.

7. Use the Chain-of-Custody Form to document the types and numbers of soil samples collected and logged.

8. Record the time and date of sample collection as well as a description of the sample and any associated air monitoring measurements in the field logbook.

9. Abandon the hole according to applicable State regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

10. Decontaminate sampling equipment as per EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination.

D. Sampling at Depth with a Split Spoon (Barrel) Sampler

The procedure for split spoon sampling describes the extraction of undisturbed soil cores of 18 or 24 inches in length (Appendix C). A series of consecutive cores may be sampled to give a complete soil column, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

This sampling device may be used to collect such information as soil density. All work should be performed in accordance with ASTM D 1586-84, Penetration Test and Split Barrel Sampling of Soils.

1. Assemble the sampler by aligning both sides of barrel and then screwing the bit on the bottom and the heavier head piece on top.

2. Place the sampler in a perpendicular position on the sample material.

3. Using a sledge hammer or well ring, if available, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.

4. Record the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.

5. Withdraw the sampler, and open by unscrewing bit and head and splitting barrel. If split sampler is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is available in 2 and 3 1/2 inch diameters. The required sample volume may dictate the use of the larger barrel. When split tube sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D 1586-67 (reapproved 1974).

6. Cap the sample container, place in a double plastic bag and attach the label and custody seal. Record all pertinent data in field log book and complete the sample analysis request form and Chain of Custody record before taking the next sample.

7. If required, preserve and/or place the sample on ice.

8. Follow proper decontamination procedures and then deliver sample(s) to the laboratory for analysis.

E. Test Pit/Trench Excavation

These relatively large excavations are used to remove sections of soils, when detailed examination of soil characteristics (horizontal, structure, color, etc.) are required. It is the least cost effective sampling method due to the relatively high cost of backhoe operation.

1. Prior to any excavations with a backhoe, it is important to ensure that all sampling locations are clear of utility lines and poles (subsurface as well as above surface).

2. Using the backhoe, a trench is dug to approximately 3 feet in width and approximately 1 foot below the cleared sampling depth. Place removed or excavated soils on canvas or plastic sheets, if necessary. Trenches greater than 5 feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.

3. A shovel is used to remove a 1 to 2 inch layer of soil from the vertical face of the pit where sampling is to be done.

4. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. Samples are removed and placed in an appropriate container.

5. If required, ensure that a Teflon liner is present in the cap. Secure the cap tightly onto the sample container. Samples are handled in accordance with EPA/REAC SOP 2003, Sample Storage, Preservation, and Shipping by Parameter or Groups of Parameters.

6. Carefully and clearly, label the container with the appropriate sample tag addressing all the categories or parameters listed in EPA/REAC SOP # 2002, Sample Documentation.

7. Use the Chain-of-Custody Form to document the types and numbers of soil samples collected and logged.

8. Record the time and date of sample collection as well as a description of the sample and any associated air monitoring measurements in the field logbook.

9. Abandon the hole according to applicable State regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

10. Decontaminate sampling equipment including the backhoe bucket, as per EPA/REAC SOP # 2006, Sample Container and Equipment Decontamination.

7.4 Post Operation

A. Field

1. Decontaminate all equipment according to EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination.

B. Office

1. Finalize field notes into a report format and/or transfer logging information to appropriate forms.

8.0 CALCULATIONS

There are no specific calculations required for these procedures.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 Sampling Documentation

A. All soil samples shall be documented in accordance with EPA/REAC SOP# 2002, Sample Documentation. The soil sample label is filled

out prior to collecting the sample, and should contain the following:

1. Site name or identification.
2. Sample location and identifier.
3. Date samples were collected; in a day, month, year format (e.g., 03 JAN 88 for January 3, 1988).
4. Time of sample collection, using 24 hour clock in format hours and minutes.
5. Sample depth interval. Units used for depths should be in feet and tenths of feet.
6. Preservatives used, if any.
7. Analysis required.
8. Sampling personnel.
9. Comments and other relevant observations (e.g., color, odor, sample technique).

B. Logbook

A bound, field notebook will be maintained by field personnel to record daily activities, including sample collection and tracking information. A separate entry will be made for each sample collected. These entries should include information from the sample label and a complete physical description of the soil sample including texture, color (including notation of soil mottling) consistency, moisture content, cementation, and structure.

C. Chain of Custody

Use the Chain-of-Custody Form to document the types and numbers of soil samples collected and logged. Refer to EPA/REAC SOP# 2002, Sample Documentation for directions on filling out this form.

9.2 Sampling Design and Quality Assurance

1. Sampling situations vary widely and therefore no universal sampling procedure can be recommended. However, a sampling plan should be implemented before any sampling operation is attempted.

2. Any of the sampling methods described here should allow a representative soil sample to be obtained if the sampling plan is properly designed.

3. Consideration must also be given to the collection of a sample representative of all horizons present in the soil. Selection of the proper sampler will facilitate this procedure.

4. A stringent quality assurance project plan should be outlined before any sampling operation is attempted. This should include, but not be limited to, laboratory clean samplers and sample containers, chain of custody procedures, and duplicate samples.

10.0 DATA VALIDATION

The data generated will be reviewed according to the Quality Assurance/Quality Control considerations identified in Section 9.0.

11.0 HEALTH AND SAFETY

A. Hazards Associated with On-Site Contaminants

Depending upon site-specific contaminants, various protective programs must be implemented prior to soil sampling. The site Health and Safety plan should be reviewed with specific emphasis placed on a protection program planned for other direct contact tasks. Standard safe operating practices should be followed including minimization of contact with potential contaminants in both the vapor phase and solid matrix by using both respirators and disposable clothing.

Use appropriate safe work practices for the type of contaminant expected (or determined to be in previous sampling efforts):

1. Particulate or Metals Contaminants

- Avoid skin contact with and/or incidental ingestion of soils and dusts.
- Use long sleeve protective gloves.

2. Volatile Organic Contaminants

- Pre-survey the site with an FID/PID prior to taking soil samples.
- If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

B. Physical Hazards Associated with Soil Sampling

1. Lifting injuries associated with moving equipment.

2. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.
3. Slip, trip, fall conditions as a result of site obstacles.
4. Restricted mobility due to the wearing of protective clothing.

12.0 REFERENCES

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USEPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

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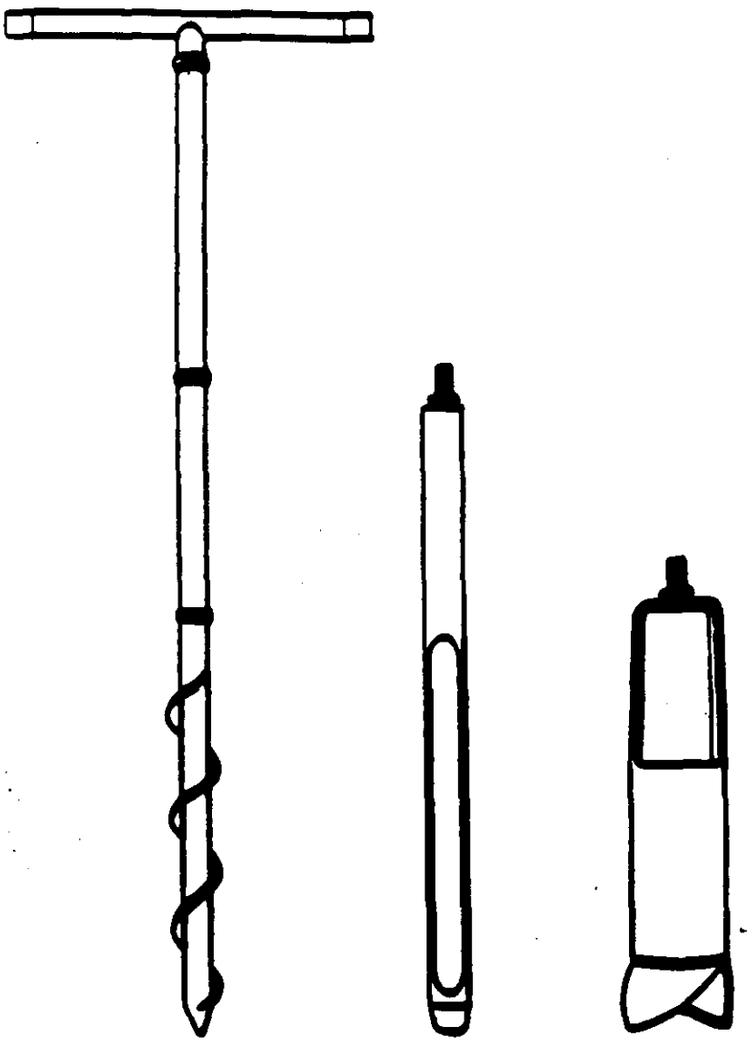
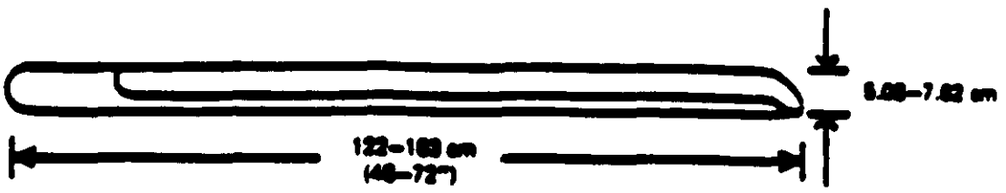
APPENDIX A

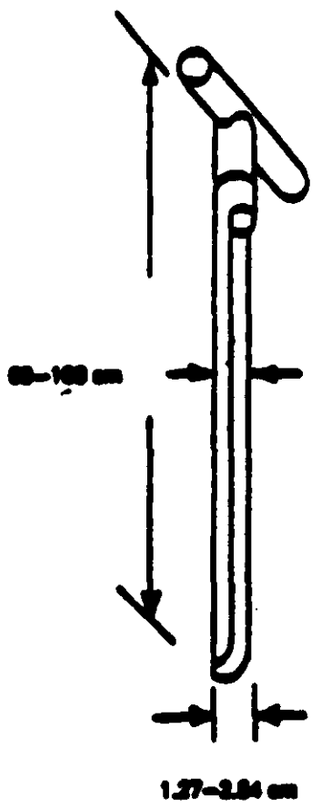
SAMPLING AUGER



APPENDIX B

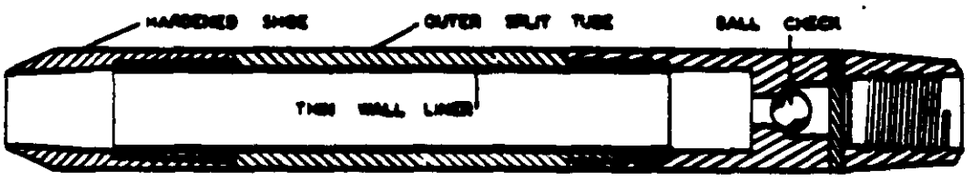
SAMPLING TRIER





APPENDIX C

SPLIT SPOON SAMPLER



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1.0 SCOPE AND APPLICATION

This recommended protocol outlines procedures and equipment for the collection of representative liquid samples (aqueous and nonaqueous) from streams, rivers, lakes, ponds, lagoons, and surface impoundments. This includes samples from depth as well as surface samples.

2.0 METHOD SUMMARY

Sampling situations vary widely and therefore, no universal sampling procedure can be recommended. A sampling plan must be completed before any sampling operation is attempted. The sampling plan should include objectives of the study, number and type of samples required to meet these objectives, and procedures to collect these samples based upon site characteristics.

The sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

Kemmerer bottle
Bacon bomb
Dip sampler
Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface water and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Sample preservation, sample containers, sample holding, and sample storage are critical concerns for many types of analyses. Once the analyses to be performed are determined, EPA/REAC SOP# 2003 should be consulted to determine the above parameters. This must be completed prior to field sampling.

Once the samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable labeled sample containers.
2. Preserve the sample if appropriate or use preserved sample bottles.
3. Cap the container, place in a ziploc plastic bag and place in a iced cooler if required.
4. Record all pertinent data a the field logbook and upon a Field Data Sheet.

5. Complete Chain of Custody record and sample analysis request form.
6. Attach custody seals to cooler prior to shipment.
7. Decontaminant all sampling equipment prior to the collection of additional samples.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There a two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and bottles. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, the disturbance of stream or impoundment substrate, and sampling in an obvious disturbed area such as that caused by a boat wake. Following proper decontamination procedures and minimizing disturbance of sample site will eliminate these problems.

5.0 EQUIPMENT

Equipment needs for collection of surface water samples include:

Kemmerer bottles
Bacon bomb
Dip sampler
Line and messengers
Sample bottles, preservatives, ziploc bags, ice, coolers
Chain of Custodies, Field Data Sheets
Decontamination equipment
Protective clothing

6.0 REAGENTS

Reagents will be utilized for the preservation of samples and for the decontamination of sampling equipment. Appropriate preservation and decontamination procedures (EPA/REAC SOP# 2006) will be selected prior to field sampling. Preservatives commonly used include:

Nitric acid (HNO_3)
Sodium hydroxide (H_aOH)
Sulfuric acid (H_2SO_4)

Decontamination reagents include:

Nitric acid (HNO_3)
Acetone
Deionized or distilled water

7.0 PROCEDURES

7.1 Sampling Considerations

7.1.1 General Site Survey

Prior to the initiation of any sampling operation, the immediate area should be checked for radioactivity, Photo Ionization Potential, and explosively.

Prior to the actual sampling, consideration must be given to the specific sampling points in order to provide a representative sample. This consideration, as well as others, should be detailed in the Sampling Plan. Accessibility is one of the primary considerations.

7.1.2 Representative Samples

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments flow patterns in streams, and appropriate sample locations and depths. Additional references are listed in Section 12.0.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

- Whether the sample will be collected from shore or from a boat on the impoundment.
- The desired depth at which you wish to collect the sample.
- Depth and flow of river or stream.

7.1.3 Sampler Composition

The appropriate device must also be of a proper composition. Samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be used depending upon the analyses to be performed.

7.2 Sample Collection

7.2.1 Kemmerer Bottle

A Kemmerer bottle may be used in most situations where site access is from a boat or structure such as a bridge or pier and where samples at depth are required. Sampling procedures are as follows:

a. Using a properly decontaminated Kemmerer bottle set the sampling device so that the sampling end pieces are pulled away from the sampling tube, allowing the substance to pass through this tube.
b. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.
c. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.
d. Retrieve the sampler.

Additional information concerning the Kemmerer bottle can be found in EPA/REAC SOP# 2130.

7.2.2 Bacon Bomb

This type of sampler may be used in similar situations as those outlined for the Kemmerer bottle. Sampling procedures are as follows:

a. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut.
b. Release the trigger line and retrieve the sampler. Transfer the sample to the sample container by pulling upon the trigger.

Additional information concerning this device can be found in EPA/REAC SOP# 2124.

7.2.3 Dip Sampler

A dip sampler is useful for situations where a sample is to be recovered from an outfall pipe such as through a storm sewer grating or along a lagoon bank where direct accessibility is limited. The long handle on such a device allows access from a discrete location. The procedures are as follows:

a. Assemble the device in accordance with the manufacturers instructions.

b. Extend the device to the sample location and collect the sample.
c. Retrieve the sampler.

7.2.4 Direct Method

For streams, rivers, lakes, and other surface waters the direct method may be utilized to collect water samples from the surface. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants are a concern.

Using adequate protective clothing (i.e. gloves, hip waders), access the sampling station by appropriate means (wading, boat). For shallow stream stations collect the sample under the water surface pointing the sample container upstream. The container must also be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

8.0 CALCULATIONS

This procedure does not involve specific calculations.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within field/-site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

3. All deliverables will receive a peer review prior to release.

10.0 DATA VALIDATION

The data generated will be reviewed according to the Quality Assurance/Quality Control considerations listed in Section 9.0.

11.0 HEALTH AND SAFETY

Personal safety is always the most important factor in any sampling operation. A situation should always be considered as the worst case scenario with the appropriate personal protection until determined otherwise.

When sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the sampler's safety. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him/her to lose their balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment.

When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures will be followed. Boating safety and lagoon safety are outlined in EPA/REAC SOP# 3012.

12.0 REFERENCES

The following references should be consulted for additional information concerning collection equipment and proper collection methods:

U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination Reston, Virginia. (Chapter Updates available).

U.S.E.P.A. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

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1.0 SCOPE AND APPLICATION

This protocol describes the procedures for the collection of representative sediment samples. Analysis of sediments may determine whether concentrations of specific contaminants exceed established threshold action levels, or, if the concentrations present a risk to public health, welfare, or the environment.

The methodologies discussed in this procedure are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by the sampling area.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static, as in lakes and ponds, or flowing, as in rivers and streams.

2.0 METHOD SUMMARY

Sediment samples may be recovered using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed) and the sediment type.

Sediment is collected from beneath an aqueous layer either directly, using a hand held device such as a shovel, trowel, or auger, or indirectly using a remotely actuated device such as a Ekman or Ponar dredge. Following collection, the sediment is placed into a container constructed of inert material, thoroughly blended, and transferred to the appropriate sample containers.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time. Refer to EPA/REAC SOP# 2003, Sample Storage, Preservation,and Shipping by Parameter or Group of Parameters.

3.2 Wide mouth glass containers with Teflon lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the work plan.

5. This sampler may be used with either a drive hammer for firm consolidated sediments, or a "T" handle for soft sediments.
6. Place the sampler in a perpendicular position on the material to be sampled.
7. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. Rotate the sampler to shear off the core of the bottom and proceed to step 15.
8. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.
9. With left hand holding the tube, drive the sampler into the material to the desired hammer. Do not drive the tube further than the tip of the hammer's guide.
10. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.
11. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.
12. Rotate the sampler at least two revolutions to shear off the sample at the bottom.
13. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90^0.
14. Withdraw the sampler by pulling the handle (hammer) upwards and dislodging the hammer from the sampler.
15. Unscrew the coring point and remove the eggshell check valve.
16. Slide the acetate core out of the sampler tube. The acetate core may be capped at both ends. The sample may be used in this fashion, or the contents transferred to a stainless steel or plastic bucket and mixed thoroughly to obtain a homogeneous sample representative of the entire sampling interval.
17. Samples for volatile organic analysis will be collected directly from the bucket before mixing the sample to minimize volatilization of contaminants.

7.3 Post Operation

7.3.1 Field

Decontaminate all equipment according to EPA/REAC SOP# 2006, Sample Container and Equipment Decontamination, both prior to and following all sampling events.

7.3.2 Office

Finalize field notes and/or transfer logging information into report format.

8.0 CALCULATIONS

There are no specific calculations required for sediment sampling.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain-of-custody forms, field data sheets or within field/site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

3. All deliverables will receive peer review prior to release.

The following specific quality assurance activity will apply:

A stringent quality assurance work plan should be outlined before any sampling operation is attempted. This should include but not be limited to, laboratory clean samplers and sample containers, QA/QC samples, and background samples if specified in the sampling plan (work plan) using the procedure outlined in Section 7.0.

10.0 DATA VALIDATION

The data generated will be reviewed according with the QA/QC considerations included in Section 9.0.

11.0 HEALTH AND SAFETY

The preparation of a Health and Safety Plan is required prior to any field activity. The plan must be approved and signed by the REAC Health and Safety Officer or his/her designee.

When sampling sediment from waterbodies containing known or suspected hazardous substances, adequate precautions must be taken to ensure the sampler's safety. The team member collecting the sample should not get too close to the edge of the waterbody, where bank failure may cause

him/her to lose their balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. Extra precautions must be taken if a waterbody such as a lake or stream from which a sample is being taken contains known or suspected hazardous substances. If sampling from a vessel is determined to be necessary, appropriate protective measures (i.e.: flat-bottom boat, life preservers, back-up team) must be implemented, as per Health and Safety SOPs (EPA/REAC SOP Series 3000).

12.0 REFERENCES

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

USEPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

FIGURE 1 - SAMPLING AUGER

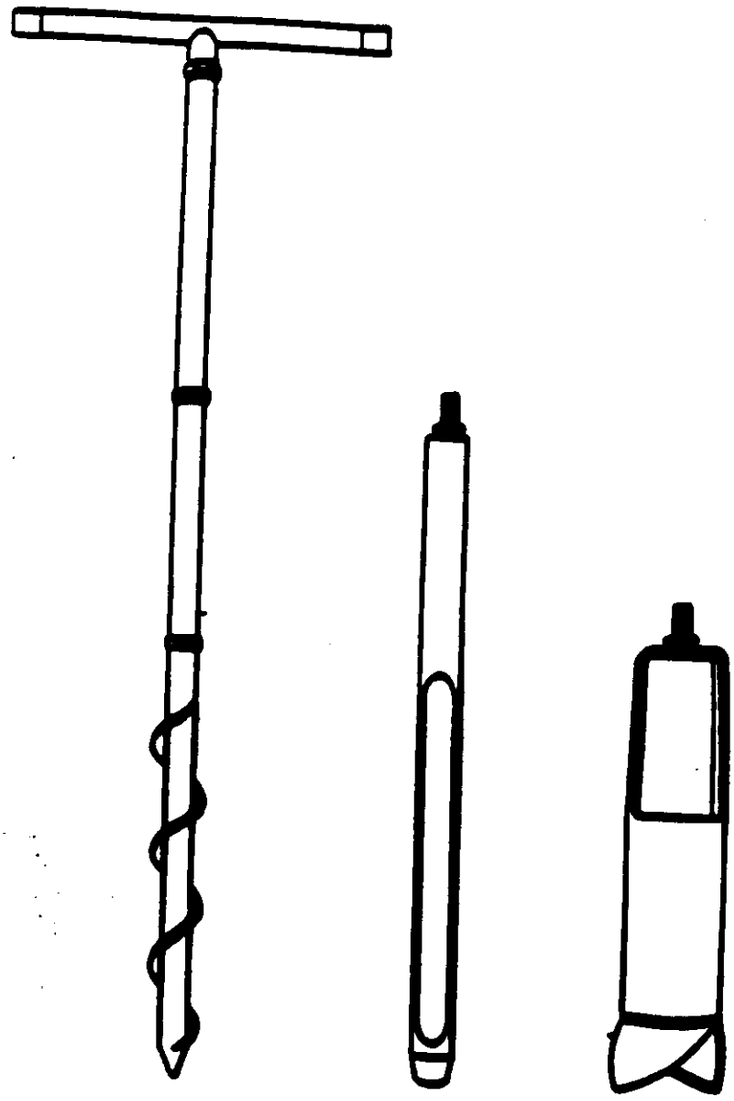


FIGURE 2 - SAMPLING TRIER

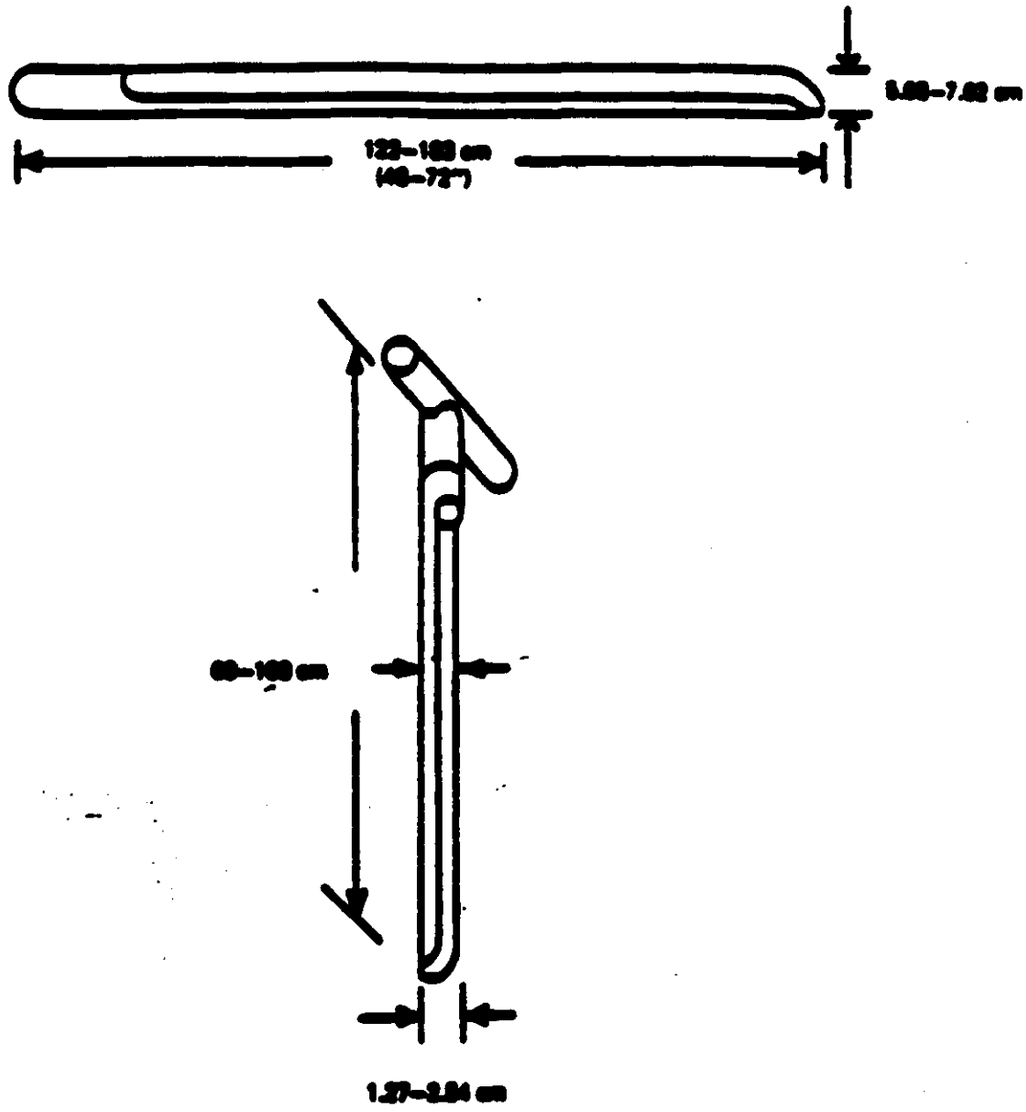


FIGURE 3 - EKMAN DREDGE

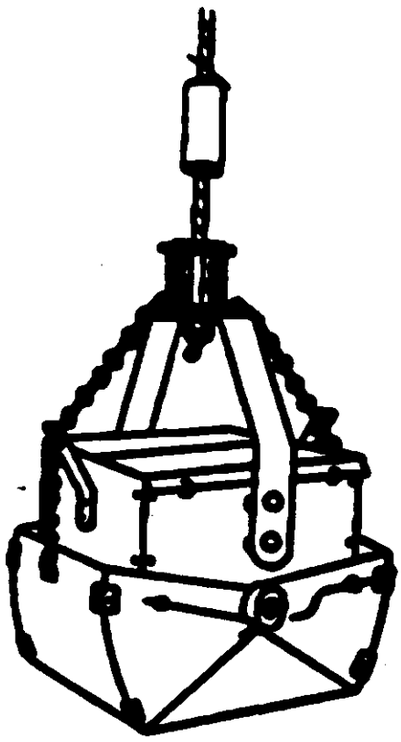


FIGURE 4 - PONAR DREDGE

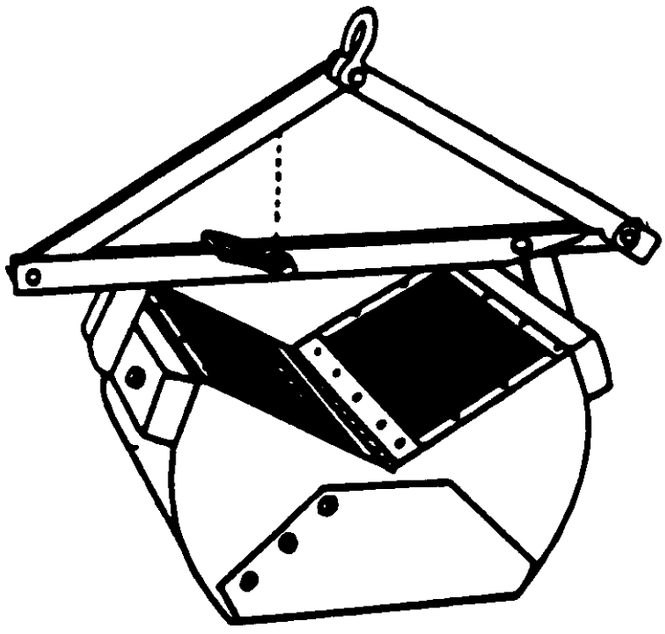
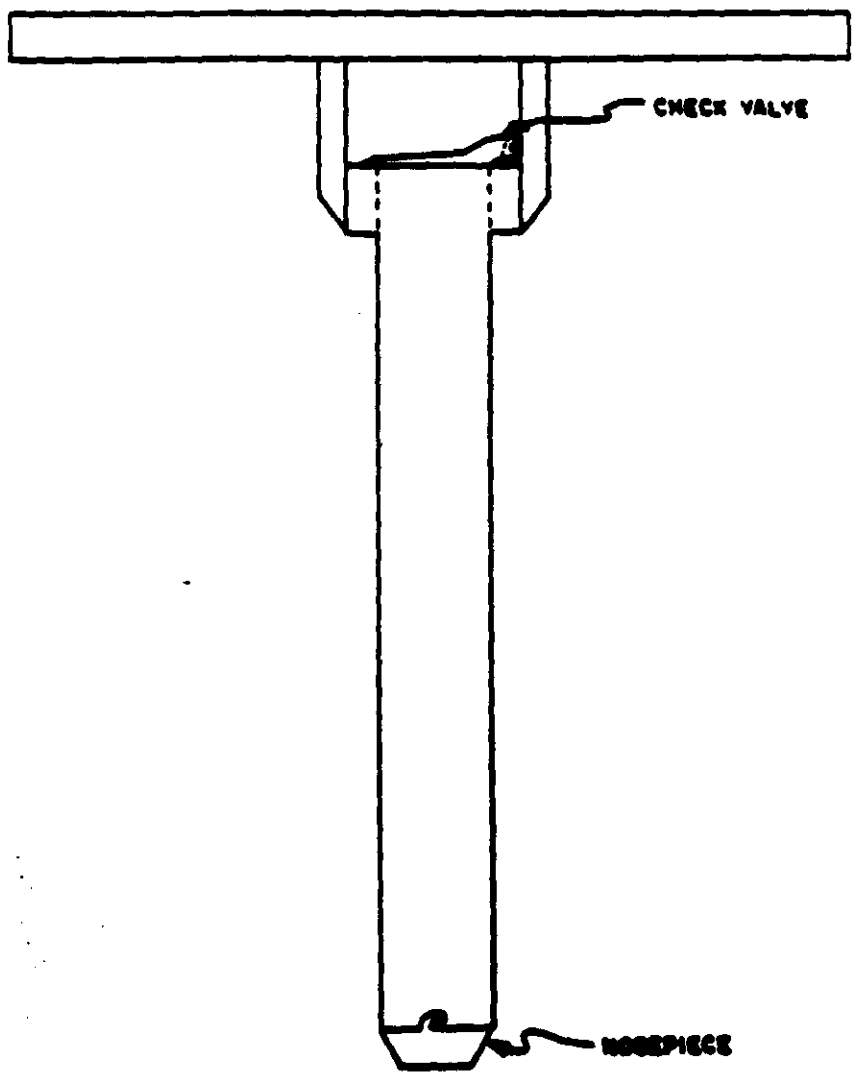


FIGURE 5 - SAMPLING CORE DEVICE



SMALL MAMMAL SAMPLING

1.0 SCOPE AND APPLICATION

This document outlines the procedures for the sampling of small mammal populations. Collection of small mammals may be an integral component in the ecological assessment of a site. Small mammals can be utilized as indicators of contaminant bioaccumulation for risk assessments or potential biomagnification of contaminants at higher trophic levels. Chronic and acute toxic responses to chemical contamination can be reflected by the population estimates derived from these sampling procedures. The methodologies discussed in these procedures focus on securing representative samples for population estimates and others metrics, recording indigenous species for site description, and field preparation/preservation of samples for residue and histopathological analysis. Also addressed are quality assurance/quality control methods and sample documentation.

2.0 METHOD SUMMARY

The initial phase of small mammal sampling involves selection of on-site locations and an off-site reference area. Trap locations will be selected on the basis of favorable small mammal habitat. Sampling locations will be staked out and grid dimensions defined according to available habitat. Small mammal sampling will involve the use of live, snap or pitfall trapping techniques dependent on project goals. Live trapping techniques will be utilized for all mark-recapture population studies and specimens to be analyzed for tissue contaminant loads. Snap and/or pitfall trapping will be used for site surveys, specific target species or as a compliment to live trapping. All specimens will have weight, metrics, and pertinent necropsy information recorded on individual small mammal data sheets. Only those individuals to be retained for tissue analysis will undergo a complete necropsy. Selected internal tissues and/or organs will be removed, wrapped in aluminum foil or placed in glass jars and stored on dry ice. Additional tissue may be removed and preserved for histopathological analysis.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Small mammal sampling for tissue analysis will involve obtaining at least 20 grams of specific tissue (e.g. adipose, liver, etc.) from each individual unless whole body analysis is to be performed. Sufficient samples will be attained to be representative of the sampling area and/or adequate for statistical confidence.

All tissues for chemical analysis other than metals will be wrapped in aluminum foil. Any tissue retained for metals analysis will be stored in a glass container. Tissues retained for histological analysis will be stored in 40 ml vials in 4% paraformaldehyde solution. All tissues that are not preserved should be stored on dry ice.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Live trapping of small mammals may lead to capture of non-target species. Release of all non-target species should be done quickly and at the same location of capture. Traps should be checked at regular, short intervals to prevent animal loss.

Less than 20 grams of target tissue may be secured for a parameter due to low quantities of specific tissue per animal. In this case, whole body analysis would be mandated.

Sample design should be targeted so that sufficient data is obtained for statistical confidence.

5.0 EQUIPMENT/APPARATUS

- Work Plan
- Maps/Plot Plan
- Safety Equipment per H&S Plan
- Specimen Data Sheets
- Compass
- Tape Measure
- Survey stakes/flags
- Camera
- Hand Scale
- Triple Beam Balance Scale with Cage
- Dissecting Trays (20 cm x 30 cm)
- 4 oz. Glass Jars
- Pitfall traps (20 cm diameter 30 cm high)
- Live and/or snap traps
- 15.2 or 20.3 cm toothed thumb forceps
- Spade or Shovel
- Trowel
- Woodsman's Pal
- Scalpels
- Scalpel blades
- 25.4 or 12.7 cm straight blade scissors
- Bone scissors
- Aluminum Foil
- Plastic Wrap
- Sealable Plastic bags
- 4% Paraformaldehyde
- Dissecting Table
- Chairs

6.0 REAGENTS

A 4% paraformaldehyde solution will be used in preservation of tissues for histological analysis. The preparation of it is as follows:

- 56.3 grams sodium phosphate monobasic monohydrate
- 12.9 grams NaOH
- 120 grams paraformaldehyde
- 3 liters water

1. Place 2 liters of water in a 4 liter beaker over medium heat.
2. Add sodium phosphate and dissolve.
3. Add NaOH and dissolve.
4. Add paraformaldehyde and dissolve.
5. Heat to 65^{o}C while stirring until solution clears (30 minutes to one hour).
6. Filter solution.
7. Rinse beaker with remaining 1 liter of water and add to the solution.

7.0 PROCEDURES

7.1 Office Preparation

A. The preparation of a Health and Safety Plan is required prior to any sampling. The plan must be approved and signed by the Health and Safety Officer or his/her designee.

B. Prepare a work plan in accordance with EPA/REAC SOP 2014, Quality Assurance Work Plan Preparation. Review all available background information such as topographic maps, soil survey maps, geologic survey maps, other site reports, etc., to determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.

C. Obtain necessary sampling and monitoring equipment (see Appendix A). Decontaminate or preclean equipment, and ensure that equipment is in working order.

D. Contact delivery service to confirm ability to ship all equipment and samples, which may fall under various shipping restrictions.

E. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.

7.2 Field Preparation

A. Identify local suppliers of sampling expendables (e.g., ice, plastic bags) and overnight delivery services (e.g., Federal Express, Emery, Purolator).

B. Decontaminate or preclean equipment before sampling as described in SOP 2006, Sample Container and Equipment Decontamination. Do not clean small mammal traps with chemicals or detergent. Use of these substances will impregnate traps with unnatural odors and

cause trap avoidance. Superficial cleaning of traps may be done with water or utensils if absolutely necessary. Adjustment of trap mechanism sensitivity may be necessary. To insure trapping success, inspect all traps and mechanisms before field work begins.

C. A general site survey should be performed prior to site entry in accordance with the Health and Safety Plan.

D. Specific on-site sampling locations and a reference area should be selected. The reference area should be situated adjacent to the main site, have similar habitat features, and be free of all contaminants. These features will help insure valid comparison of small mammal data from on-site areas.

E. Identify and stake all sampling locations. The proposed locations may be adjusted based on site access, property boundaries, surface obstructions and habitat availability.

F. A processing area for captured small mammals will be set aside in the safety zone. Set-up for this area will include all appropriate equipment listed in Section 5.0 for measuring, dissecting, and preserving of specimens. A trap reserve will also be maintained to serve as a replacement for successful traps brought back to the processing area.

7.3 Sample Collection

1. Determination of specific sampling technique will be accomplished before commencement of field activities. Box traps will be used for all live trapping. Cervical dislocation snap traps or pitfall traps will be used as killing traps.

2. Live and snap traps can be baited with peanut butter, nuts, grain, or some combination of those items. Baiting will be contingent on the specific dietary preference of the target species. Baiting should always occur before trap mechanisms are set. Live traps may be used without bait for capture of specimens with runway habituation behavior.

3. Pitfall traps should be made of plastic containers approximately 30 cm high and 15 cm in diameter. They should be filled with 10 cm of deionized water. Small pits should be excavated for each trap so that the container lip is flush with the soil surface. A small trowel or shovel will aid in excavation.

4. Traps should be set along transect lines with a 3 m interval between traps. A grid system will be used with representative sampling points selected for trapping stations. The number and orientation of transects or stations will be dependent on site conditions. Each trap station will be located within a one square meter area centered around a grid mode. Traps will be set in a runway or the most likely trap spot when a runway is not available or applicable such as the base of a tree, along a fallen log, etc.

5. The number of trap nights (trap number x number of days run) will be dependent on the specific project goals. The time frame for collecting should consistent throughout the collection period with time frames from dusk to dawn or dawn to dusk.

6. Live and snap trap stations that are successful will be removed with specimens intact and replaced by a trap from the trap reserve. Successful pitfall trap stations will have specimens only removed by hand or with the aid of forceps. All specimens will be brought to the central staging area for processing. All successful trap locations will be recorded on specimen data sheets (SDS).

7. All specimens collected, should be identified, weighed, and measured. Identification should include species name and sex-reproductive status determination when possible. Specimens will be weighed using a triple beam balance with a holding cage. All animal weights will be recorded to the nearest 0.1 gram (gm). Additional measurements should include total, tail, and hind foot length to the nearest millimeter (mm). All weights and measurements are to be recorded on individual specimen data sheets (SDS). Live specimens to be retained for tissue or histological analysis will be sacrificed by cervical dislocation.

8. Protective leather or latex gloves should be worn when handling all specimens. Handling time on live specimens should be kept to a minimum. All live animals not scarified should be released in the same area where they were captured.

9. If successive trapping surveys are necessary for population estimates, then specimens will be tagged or toe-clipped before release. All subsequent captures and recaptures will be recorded, coded and released in the same manner.

10. If field dissection for removal of specific tissue or organs is necessary, then dissection should take place on decontaminated dissecting trays at the central staging area.

11. Dissecting procedures will include removal of the specimen's skin and a complete necropsy before any internal tissue removal. All notable internal and external conditions will be recorded on the SDS. The outer skin, underlying adipose tissue, liver, gastrointestinal tract, or whole body tissue may be retained dependent on desired contaminant target tissue analysis. Tissue or organs that are retained for analysis should be weighed to 0.1 gram. Samples should be wrapped in aluminum foil and put into labeled, sealable plastic bags or 4 oz. glass containers and stored on dry ice.

12. All discarded internal and external tissue should be disposed of with other site generated waste in accordance with EPA/REAC policy.

13. All dissecting procedures should be performed with decontaminated dissection equipment. Dissection tools may include: scalpel with replacable blades, 25.4 or 12.7 cm straight blade scissors, bone scissors, and 15.2 or 20. 3 cm toothed thumb forceps.

8.0 CALCULATIONS

All specimens captured for tissue analysis will undergo standard laboratory procedures for selected contaminant parameters. Statistial analysis on the laboratory data will be performed using the SAS statistical program.

Mark recapture studies to estimate population sizes will utilize the Lincoln Index. The Lincoln Index centers around the ratio:

$$N = \frac{Mn}{m}$$

where N = the population, M = the number marked and released, n = the total caught and, m = the number recaptured.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 Sampling Documentation

A. All vertebrate samples shall be documented in accordance with SOP 2002, Sample Documentation. Each vertebrate sample obtained will have a specimen data sheet (SDS) filled out for it

(Appendix). Additionally, a specimen tag should be tied to the right rear foot of any animal retained for archiving. Each tag should contain the site location and identification number.

B. Logbook

1. A bound field notebook will be maintained by field personnel to record daily activities, including sample collection. Entries will be made in waterproof ink. A separate entry will be made for each sample collected.

2. Entries will include all information from the specimen label and any relevant observations (e.g., vertebrate appearance, weather conditions, site appearance, etc.).

3. Photodocumentation will be performed on field procedural activities and all notable conditions.

C. Chain of Custody

1. The chain-of-custody form shall be used to document the types and numbers of vertebrate samples collected and logged. Refer to SOP 2002, Sample Documentation for directions on filling out this form.

D. Sample Design & Quality Assurance

A. Representative samples should be collected from all available habitat types for population estimates. If only tissue analysis is to be performed then sample design should include only the most favorable habitat types.

B. A trap grid should be diagrammed for each area before sampling begins. Topics to be addressed include specific sample location, grid size, the number of trap stations per grid, and the total number of trap nights desired. If habitat constraints are apparent then, variations or changes in trap grid configuration may be made onsite by the Work Assignment Manager. Trapping effort should be standardized across all sampling areas.

10.0 DATA VALIDATION

Representative individuals of each species collected and identified will be photodocumented or verified by another qualified individual in the field.

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All data on small mammal data sheets will be checked against records kept in personal field logbooks.

11.0 HEALTH AND SAFETY

Protective leather or latex gloves should be worn at all times when handling small mammals to avoid bites, scratches, or infection with ecto/endoparasites. Care should be taken during the setting of all trap mechanisms to avoid hand injury.

SMALL MAMMAL SAMPLING

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SPECIMEN DATA SHEET
SITE: _____
DATE: _____

Specimen Origin

Trap Location _____ Date collected _____

Method of collection _____ Time collected _____

Collected and/or prepared by _____

General Data

Specimen identification number _____ Live _____ Dead _____

Species _____

Sex _____ Maturity _____

Weight (grams): Total: _____ Liver: _____ Adipose: _____

Measurements (mm): Total Length: _____ Tail Length: _____ Hind Foot: _____

Necropsy

Ectoparasites found _____

Endoparasites found _____

Stomach contents _____

Abnormalities _____

Histology

Fixation date _____ Preservative _____

Tissue _____ Condition _____

Remarks

_____

_____

_____

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BENTHIC SAMPLING

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BENTHIC SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures for sampling the benthic population at hazardous waste sites. Analysis of benthos will be used, in conjunction with other bioassessment techniques, to assess the impact on benthic life from direct and/or indirect contamination.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Benthic sampling can be qualitative (a general assessment of the taxa of aquatic insects present, possibly with some observations of their relative abundance) or quantitative (an estimate of the numbers [total or by taxa] present made so that a statistical confidence of the estimate can be obtained). All representative subhabitats of a given system should be thoroughly sampled. A widely used semiquantitive method for stream benthos is kick sampling whereby a standard number of kicks dislodge organisms from comparable areas into a collection net. Qualitative sampling is also suitable for determining ratios of various functional feeding groups of aquatic insects, for example, the ratio of the number of forms that skeletonize leaf litter (shredders) to the number that graze on attached algae (scrapers).

2.1 Lentic

A variety of lentic bottom dredges (grabs) are available. Each was originally designed for one specific sampling problem. Several common collecting instruments are the Ekman dredge, the Petersen dredge, and the Ponar dredge. The Ekman dredge is the easiest to use in that it is light and relatively east to "set". However, its use is limited to soft mud, silt, or finely divided sand bottoms. Because of its relatively small sampling area, one must take many replicate samples. For sampling where the bottom material is compacted or consists of gravel, rock, or organic litter substrate, the Petersen or the Ponar dredge is preferred. The weight will vary between 15 and 30 kg, depending on the number of weights applied. Small obstacles to the closing of these dredges are crushed by the jaws, whereas the same materials would block the operation of the Ekman dredge.

2.2 Lotic

Sampling from running waters differs in both the nature of the organisms collected and the means used for the collection. Because of the scouring action of the current, soft sediments are rarely found. Organisms of running waters are either heavy bodied or have special means of attachment. Finally, because of the lack of fine sediments, the distribution of

organisms with depth in the sediment is usually greater in running waters than in standing waters.

The most commonly used sampling device for running waters is the Surber stream bottom sampler. This device has a major drawback in that its use is restricted to waters of less than 30 cm in depth and of slow to moderate velocity. Because quantitative sampling devices are lacking for other types of flowing water, the only method suitable for such situations is an indirect measurement of the benthic fauna by measurement of drift using a series of drift nets.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

After animals are separated from the water, vegetation, or substrate, they can be preserved until later analysis. Place the organisms from each sample in a separate jar or vial with a preservative such as 70% ethyl or 40% isopropyl alcohol or 5% formalin. Alcohol is less irritating to use than formalin but should be used only for short-term storage unless the animals are fixed first in formalin. For zooplankton, add 5-10 drops of Biebrich Scarlet-Eosin B solution to stain the animals so that they are more easily identified and enumerated. For algae, add 5-10 drops of Lugol's iodine solution.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are several potential problems and interferences that may occur when sampling benthic populations:

1. High water levels due to precipitation will not allow collection of a representative sample.
2. Benthic sampling is affected by seasonal factors such as freezing temperatures and ice.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for Benthic Sampling:

Surber stream bottom sampler
Garden trowels
Stiff bristle brush
Dredge, line, and messenger
Two or more metal 10- to 12- liter pails
Metal tubs
Large-diameter no. 30 screen
Wide-mouthed bottles (500 to 1,000 ml)

6.0 REAGENTS

Neutral formalin or 70% ethyl alcohol or 40% isopropyl alcohol are used for sample preservation. Decontamination of sampling equipment should follow SOP #2006, Sampling Equipment Decontamination.

BENTHIC SAMPLING

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Surber Stream Bottom Sampler

1. Select sampling site representative of area desired and with no depth greater than height of sampling frame. The velocity of flow must not be so great as to cause a "pressure head" of water to flow around mouth of net.

2. Wade into water from downstream, and place net with the mouth facing upstream in an undisturbed area. Be sure there is no disturbance of the bottom substrate upstream from the net, or organisms will be dislodged and washed into the net.

3. Lower square foot frame on substrate, and hold it in place. Pick up larger rocks or bits of substrate, and, while holding them in mouth of net, brush them free of all organisms, allowing current to carry them into net. Discard these rocks outside the frame.

4. When all larger bits have been brushed, use garden trowel to stir up all the substrate within the square foot frame. Be careful that the stirring motion is toward center of frame so that organisms that are dislodged will be carried into mouth of net and not around it. Attempt to stir this area thoroughly and to a uniform depth.

5. Depending on the number of replicates desired, move the sampler to other sites, and repeat steps 1 through 4.

6. After all replicates have been taken, empty contents of net into a wide-mouthed jar. Turn the net "wrong side out", and pick organisms that have attached to the fabric from net and place into jar.

7. Add sufficient water to cover the substrate and organisms in the bottle and then sufficient formalin to make a 5% to 10% solution. Label jar, indicating number of replicates, and return to the laboratory.

7.3 Dredges

1. Select sampling sites representative of the area to be sampled, and determine number of replications necessary. Be sure to record number of replicate samples taken.

2. Set dredge trip mechanism after securing other end of line to some fixture. These dredges are especially heavy when loaded. Take precautions to avoid dropping and loss.

3. Lower dredge to sampling site, lowering slowly through the final 0.5 m. If depth is unknown, lower to bottom and then raise, move 1 or 2 cm laterally, and relower gently. Trip dredge by dropping messenger for the Ekman or by allowing the line to slacken for the Petersen or Ponar.

4. Lift the filled dredge to the surface with a smooth, even motion to avoid jarring out contents, and swing into a pail.

5. Dump contents of dredge and pail into a washtub. If boat is large, carry out the following procedures in the boat, if not, return filled washtub to shore, and carry out the following procedures there. Repeat the sampling procedure until all the replicates have been taken.

6. Reach into the tub, and break up all compacted particles. These are especially common in areas of clay soils. Continue working the material in the tub until it is of a fine homogeneous consistency.

7. Pour the contents of the tub (use a pail to dip when the tub is full) into the No. 30 screen. Continue this step until all the contents of the tub have been poured through the screen and the tub and any pails used have been rinsed several times with water.

8. The material remaining on the screen is the collected sample. Use a sloshing, twisting, and swirling motion as you thrust the screen up and down into the water, but do not let the water run over the top of the screen. This will wash smaller materials through the sieve and at the same time will tend to concentrate the materials at one edge if you work holding the screen on a slant.

9. When all materials are concentrated in one area, scrape these into a wide-mouthed bottle, wash screen again, and place any additional materials into the bottle, picking out the last few remains with fine forceps if necessary.

10. Preserve this material with adequate neutral formalin to produce a 5% to 10% solution (one part formalin to nine parts water, ooze, and organisms).

7.4 Drift Nets

1. Set drift nets either vertically or horizontally to representatively sample the stream. They may be tied to stakes driven into the stream bottom or to tightly stretched lines fastened from bank to bank across the stream. The top of shallow nets should be just below the surface to avoid floating detritus; the bottom of deep nets should be just above the stream bottom to prevent organisms from crawling in, since such are not "drift".

2. After an appropriate time, retrieve the nets and empty contents into the wide-mouthed jars. Preserve with enough neutral formalin to make a 5% solution. Label the jars with the collection information.

7.5 Post Operation

7.5.1 Field

Decontaminate all equipment according to ERT/REAC SOP #2006, Sample Equipment Decontamination, both prior to and following all sampling events.

7.5.2 Office

Finalize field notes and/or transfer logging information into report format.

7.5.3 Laboratory Processing

The collected samples contain a mixture of mud, rocks, sand, debris, and the desired organisms. The next step is to remove the organisms from the unwanted material and separate them into similar taxonomic groupings for identification and enumeration. A variety of laboratory techniques, each specifically suited for a particular type of sample, are used by different investigators. Techniques should be modified where such a modification would lend improvement. It is important that the procedures used be nonselective so that the final list will be truly representative of the habitat sampled.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following QA/QC procedures apply:

1. All data must be documented on chain of custody forms, field data sheets or within site logbooks.

2. Samples will be duplicated in unimpacted reference sites.

3. A sample plan, including numbers and sample size, will be diagramed before sampling.

4. All deliverables will receive a peer review prior to release.

10.0 DATA VALIDATION

Taxonomic information will be confirmed on site by a regional biologist familiar with the site's benthic population.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow USEPA, OSHA, and corporate health and safety procedures.

12.0 REFERENCES

Brower, J.E. and J.H. Zar, 1984. Field and Laboratory Methods for General Ecology. William C. Brown Publishers. Dubuque, Iowa.

Lind, Owen T., 1979. Handbook of Common Methods in Limnology, Second Edison. C.V. Mosby Company. St. Louis, Missouri.

Merrit, R.W. and K.W. Cummins, 1984. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Company. Dubuque, Iowa.

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the procedures for assembly, calibration, usage, and post-calibration of the Hydrolab Surveyor II Water Quality Management System. This system is used to collect representative in-situ water quality data. The parameters quantified are temperature (°C), pH, dissolved oxygen (mg/L), conductivity (mmhos/cm), oxidation reduction potential (V), depth (m), and salinity (ppt). The data will be used in conjunction with various means of sampling and laboratory analytical data to assess water quality at these sites.

2.0 METHOD SUMMARY

The Hydrolab Surveyor II is calibrated prior to data collection at a site. Water quality data will be collected at surface water sites; if measurements are collected at locations of suspected contamination, a known unimpacted location (to be used as a reference) will also be measured. Measurements should be taken at multiple depths when feasible. The instrument will be post-calibrated immediately following field usage. In-situ water quality data will be transcribed from the digital display into a field logbook at the time of collection, or the data can be stored in a datalogger, as described in REAC SOP #2138, Operation of the Hydrolab Datalogger.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Prior to field assembly, the battery must be checked and charged if less than 10.5V. A bad or poorly charged battery will give inaccurate measurements. Caution: do not "top off" the battery; charge it only when below 10.5V. If during field measurements the dissolved oxygen (D.O.), pH, or conductivity parameters should begin to drift, consult the Hydrolab Surveyor II Operating Manual: Troubleshooting section.

5.0 EQUIPMENT/APPARATUS

The following equipment is required:

- Hydrolab Surveyor II System (see Section 7.1 and Figure 1 for a description of the components)
- Ring stand
- Clamp
- Barometer
- Logbook
- Calibration cup
- Hard plastic cap
- Soft rubber cap
- Soft paper wipes

6.0 REAGENTS

The following reagents are required for proper operation of the Hydrolab Surveyor II:

- Deionized or distilled water
- Potassium chloride (KCl) solutions (0.005, 0.01, 0.05, and 0.5M)
- pH Buffer solutions (4.00, 7.00, and 10.00 pH)

7.0 PROCEDURE

7.1 Assembly

There are five major components of the Hydrolab Surveyor II system: the Display Unit, the Data Cable, the Sonde, the Sample Circulator, and the Battery Pack (Figure 1, Appendix A). Connect the Sonde to the Data Cable through a four pin connector (Figure 2, Appendix A) and a bail (Figure 3, Appendix A). Then connect the Data Cable to the transmitter input of the Display Unit by an additional four pin connector. Connect the Battery Pack to the Display Unit input marked "Battery". After calibration, thread the Sample Circulator onto the Sonde and plug it into the Data Cable two-pin connector (Figure 4, Appendix A). Switch the selector to "Battery". If the reading is less than 10.5V, the battery needs charging.

7.2 Calibration

7.2.1 Precalibration Procedures

Assemble the Hydrolab as per Section 7.1 of this SOP. Assemble the ring stand and clamp in a manner such that it can support the Sonde as indicated in Figure 5 (Appendix A). Hold the Sonde with the clear plastic cup pointing downward and unscrew the cup. Place the Sonde in the clamp (Figure 5, Appendix A) and thread on the open ended plastic cup (calibration cup). Remove the dissolved oxygen (D.O.) probe guard (Figure 6, Appendix A) and fill the cup half full with deionized or distilled water. Seal the cup with the soft rubber cap and shake the Sonde gently. Pour off the water and repeat the previous instructions a second time.

7.2.2 Dissolved Oxygen Calibration

With the Sonde firmly clamped, fill the cup so that the tip of the D.O. probe (Figure 7, Appendix A) is submerged and cover with the soft cap. Agitate the Sonde for 15 seconds and return it to the clamp. Switch the Display Unit to "Temperature". If the temperature changes more than a tenth of a degree in five seconds, agitate the Sonde again. When the temperature becomes stabilized, remove the soft cover and pour off enough water so that the tip of the D.O. sensor is approximately 1/2 cm above the liquid surface (Figure 7, Appendix A). Blot away any water droplets on the D.O. sensor membrane with a soft paper wipe. Place the hard cap upside down on the calibration cup. Wait five minutes. While waiting, determine the local absolute barometric pressure in mmHg. Do not use weather bureau readings because they are altitude

adjusted. After five minutes, read the temperature and refer to Appendix B for the D.O. concentration that corresponds to both the ambient temperature and pressure. Switch the selector to "D.O." and allow for stabilization. Adjust the Display Unit to read the same as the table figure if necessary. This is accomplished by moving the "Slope" toggle switch up or down. This completes the D.O. system calibration.

7.2.3 Conductivity Calibration

Pour off the water in the calibration cup, blot dry any remaining water with a paper wipe and refill it above the conductivity cell block (Figure 7, Appendix A) with the KCl solution closest in conductivity to the expected conductivity range. Agitate the Sonde and return it to the clamp. Check that there are no air bubbles trapped within the sensor bores. Switch the selector to "Temperature" and wait for stabilization. Switch to "Conductivity" and use the "Slope" toggle to adjust the display reading to the conductivity of the calibration solution. Return the solution to its container and rinse the calibration cup with distilled water. This completes calibration of the Conductivity system.

The conductivity and use for each KCl solution is as follows: 0.5 M KCl (58.6 mmhos/cm) marine sampling, 0.05 M KCl (6.67 mmhos/cm) estuarine sampling, 0.01 M KCl (1.413 mmhos/cm) slightly brackish sampling, 0.005 M KCl (0.718 mmhos/cm) fresh water sampling.

7.2.4 pH Calibration

Rinse the calibration cup with distilled water and blot dry. Fill the cup above the D.O. membrane with 7.00 pH buffer solution. Allow two minutes for D.O. and thermal equilibration, then move the selector to "pH". With the "Zero" toggle switch, set the display value to 7.00 pH and return the buffer to its container. Rinse the cup with distilled water, dry, and refill it with the buffer solution closest to the expected field range (10.00 pH for pH >7 and 4.00 pH for pH <7). Wait for thermal equilibration and set the display value with the "Slope" toggle switch.

7.2.5 Saving Calibrations

After calibrating the D.O., Conductivity, and pH, set the selector on "Battery" and pull both the "Zero" and "Slope" switches away from the display. Hold them until the "SAVE" message appears, this completes the calibration sequence.

7.2.6 Depth Calibration

Immediately prior to field measurement, (i.e. at the water's edge or in the boat), hold the sensor end of the Sonde in the body of water which will be surveyed. Switch the Display Unit to "Depth", and with the "Zero" toggle, set the display to read 0.000. Turn the selector to "Battery" and pull the "Zero" and "Slope" switches away from the display. Hold them until the "SAVE" message appears.

7.3 Field Measurements

Remove the calibration cup and install the D.O. membrane guard. Thread on the circulator and connect its two-pin connector. Place the Sonde in the water and set the Display Unit to the desired parameter. Always allow ample time for D.O. and by temperature equilibration to acquire accurate readings and record them in a field logbook. D.O. readings must be stabilized and recorded first, as subsequent parameter values are based on the D.O. When measurements are complete, or interrupted, remove the circulator and replace the Storage cup half filled with distilled water. Never allow the sensors to dry out! After usage, wash the Sonde and Data Cable with soapy water and a distilled water rinse. Rinse the probes several times with distilled water and replace the storage cup, half filled with fresh distilled water.

7.4 Post-Calibration

Follow the same procedures for initial calibration except write down the final readings for the standards and incorporate them into the field data. This is important; post-calibration insures the reliability of the field measurements by demonstrating that the instrument remained calibrated throughout the entire sampling period.

8.0 CALCULATIONS

The Hydrolab Surveyor II has a direct read-out screen; however, the barometers used for calibration are read in mbar or inHg. To calibrate the instrument, the barometric pressure must be known in units of mmHg. An equation is given below for each conversion:

$$\text{mmHg} = \frac{\text{X mbar}}{1.3332}$$

$$\text{mmHg} = (\text{X inHg})\ 2.54$$

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following QA/QC procedures apply:

1. Equipment will be calibrated prior to sampling at a given site.
2. All data must be documented within field logbooks.
3. Measurements will be duplicated in an unimpacted area.
4. Equipment will be post-calibrated after use on-site.

10.0 DATA VALIDATION

Data generated will be reviewed according to the QA/QC considerations listed in Section 9.0

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow USEPA, OSHA, or corporate health and safety practices.

12.0 REFERENCES

Hydrolab Corporation, Surveyor II Operating Manual Revision A. February, 1985.

APPENDIX A

FIGURES

SOP #2139
NOVEMBER, 1990

FIGURE 1. System Components

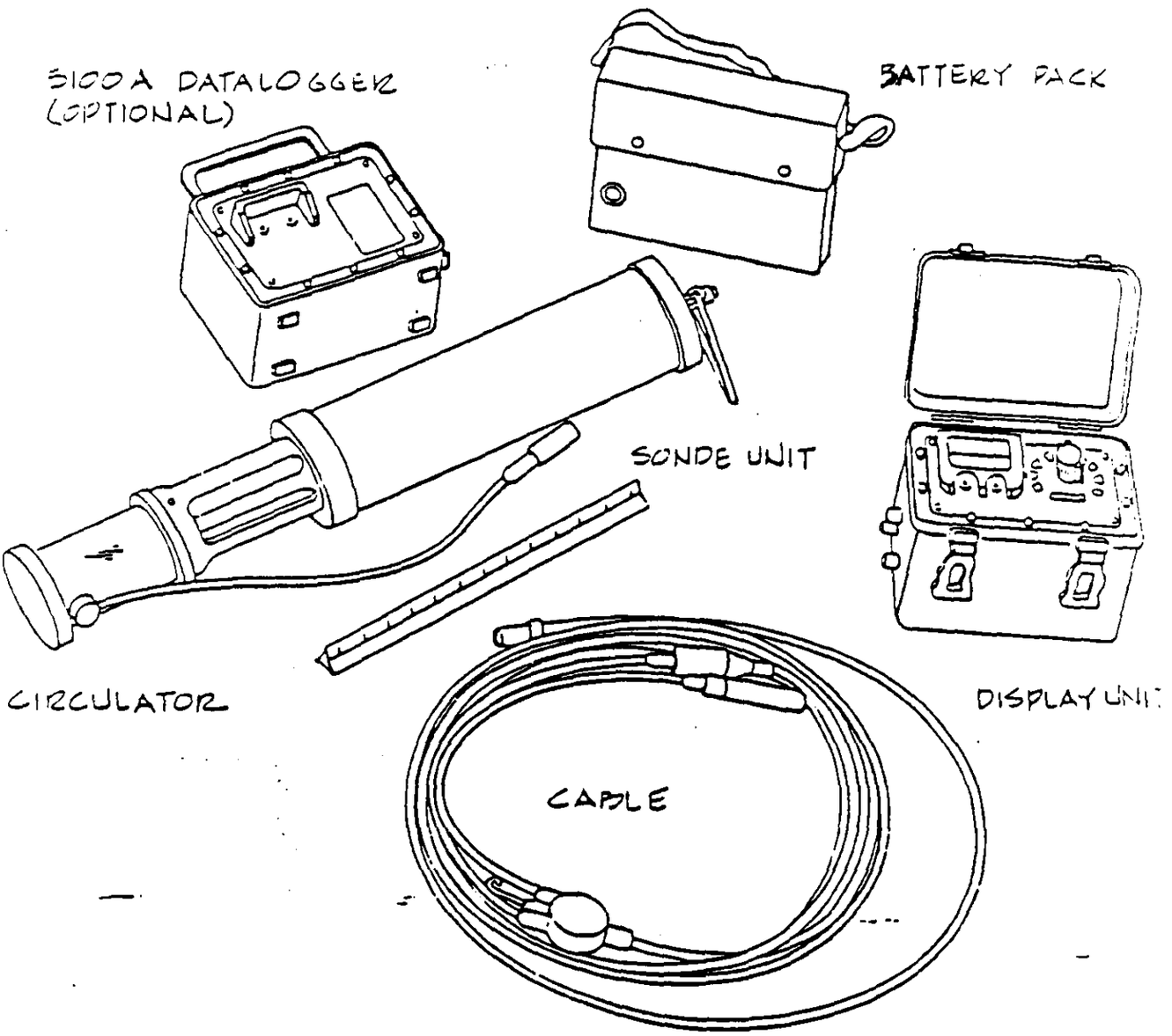


FIGURE 2. Data Cable

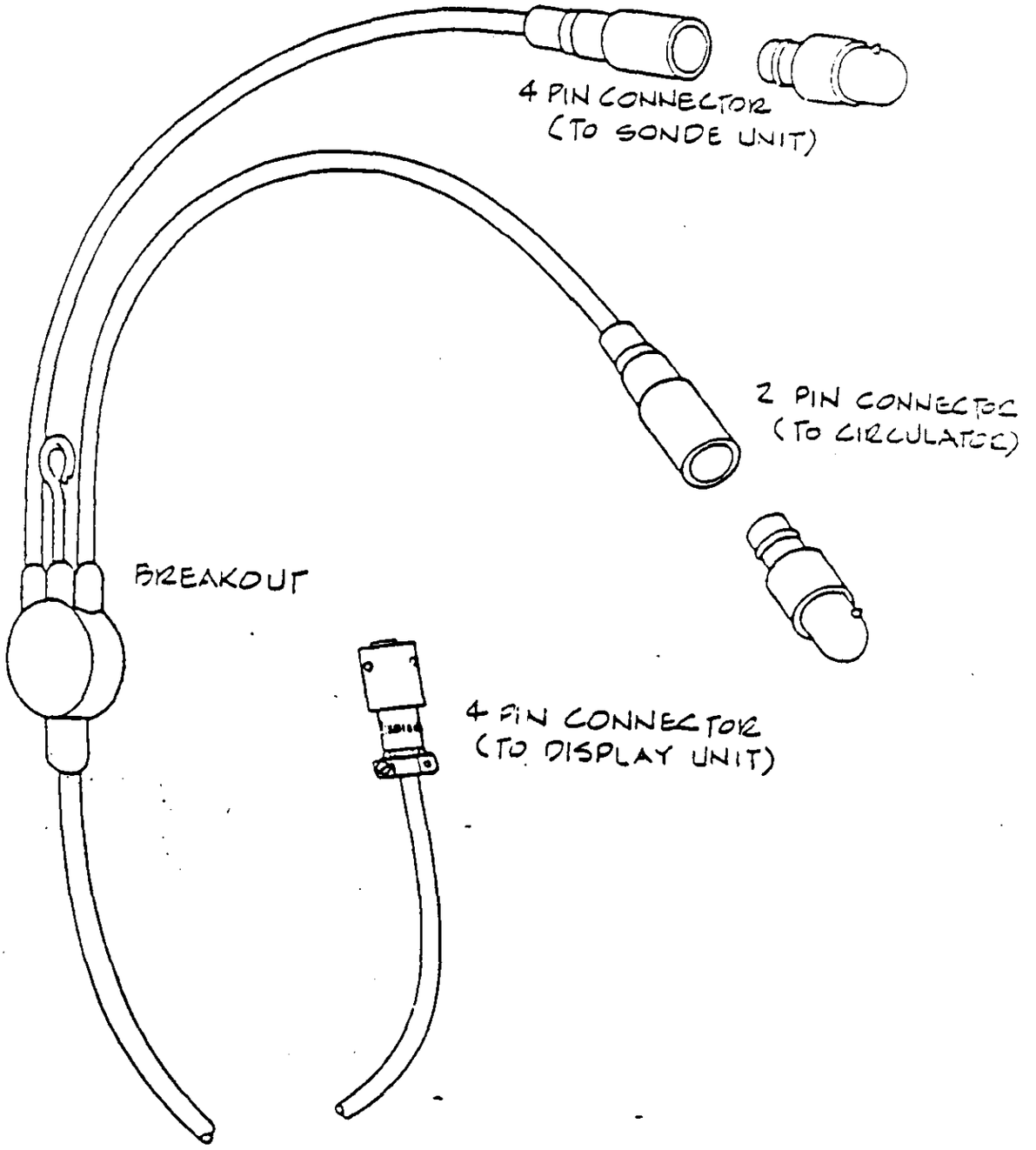


FIGURE 3. Data Cable/Sonde Connection

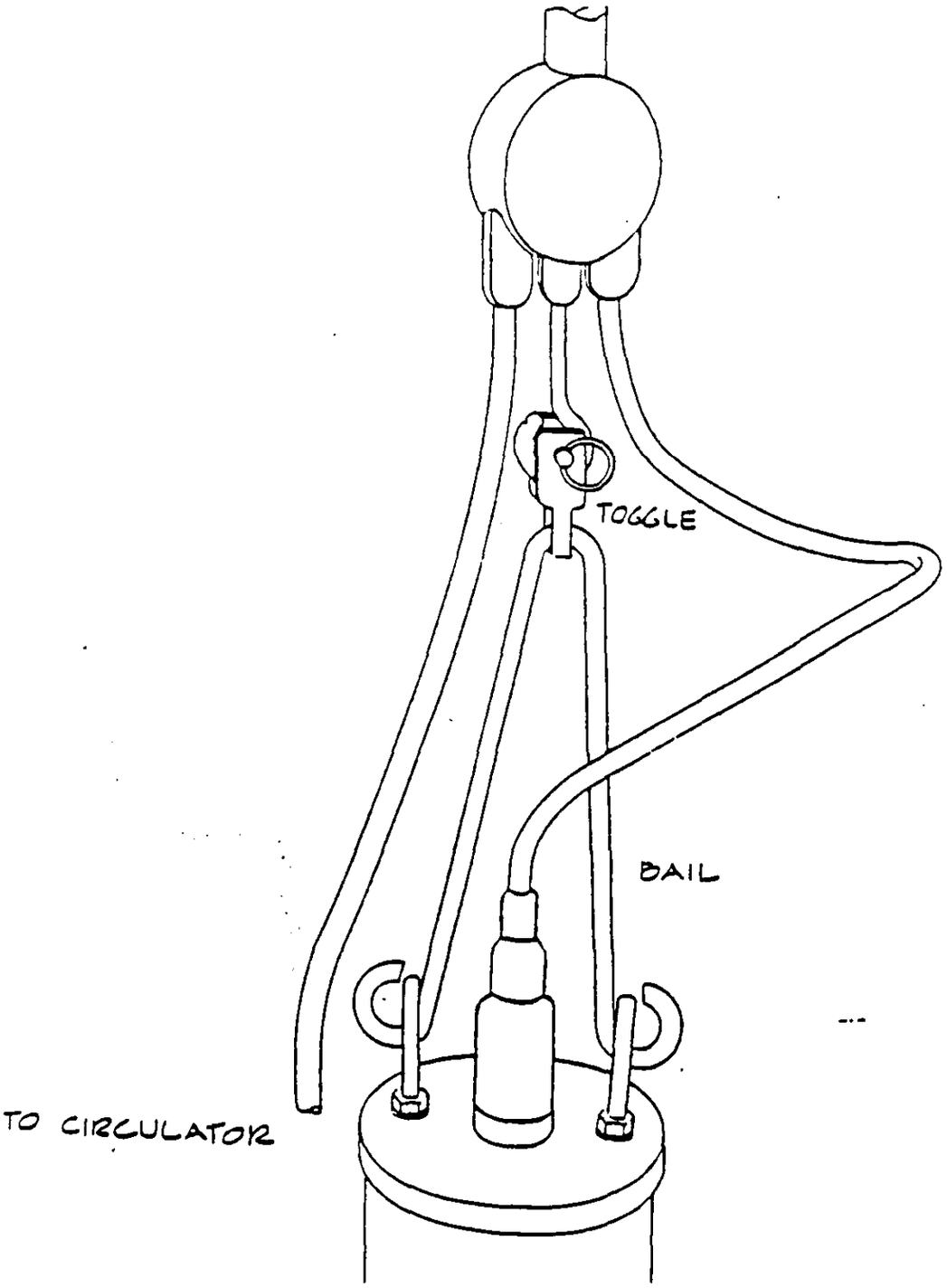


FIGURE 4. Circulator Assembly

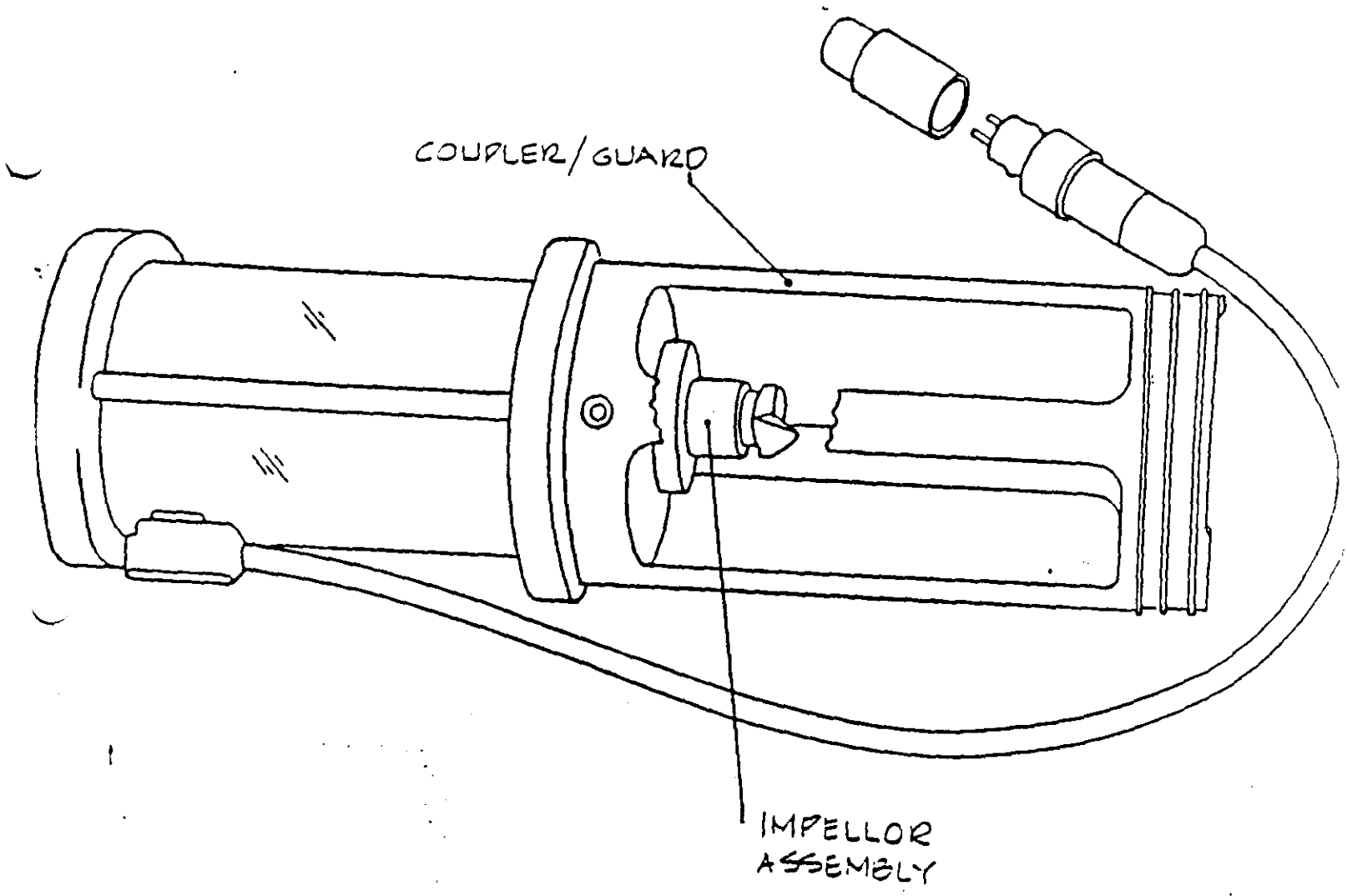


FIGURE 5. Sonde Unit in Clamp - Calibration Mode

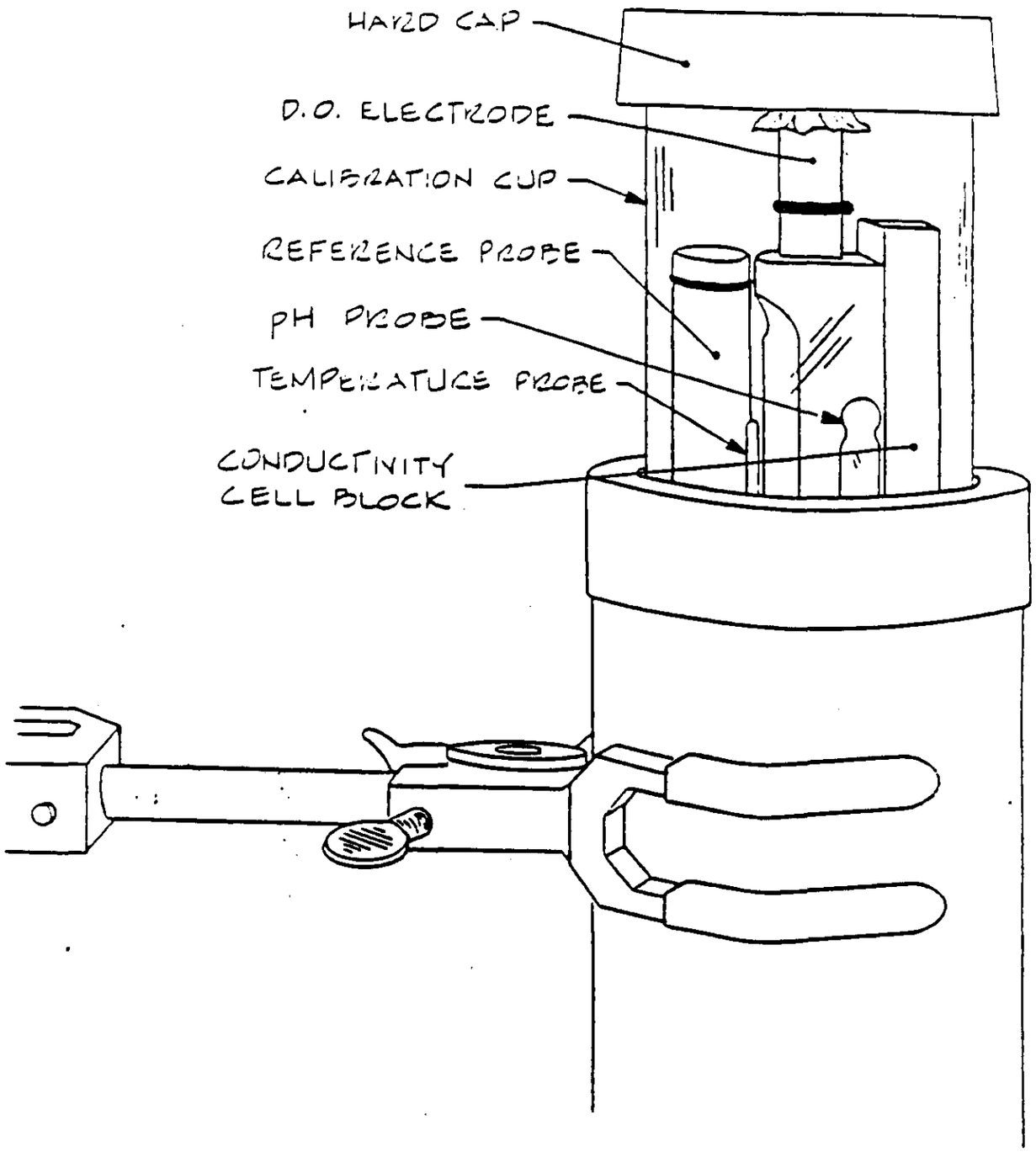


FIGURE 6. Sonde Unit

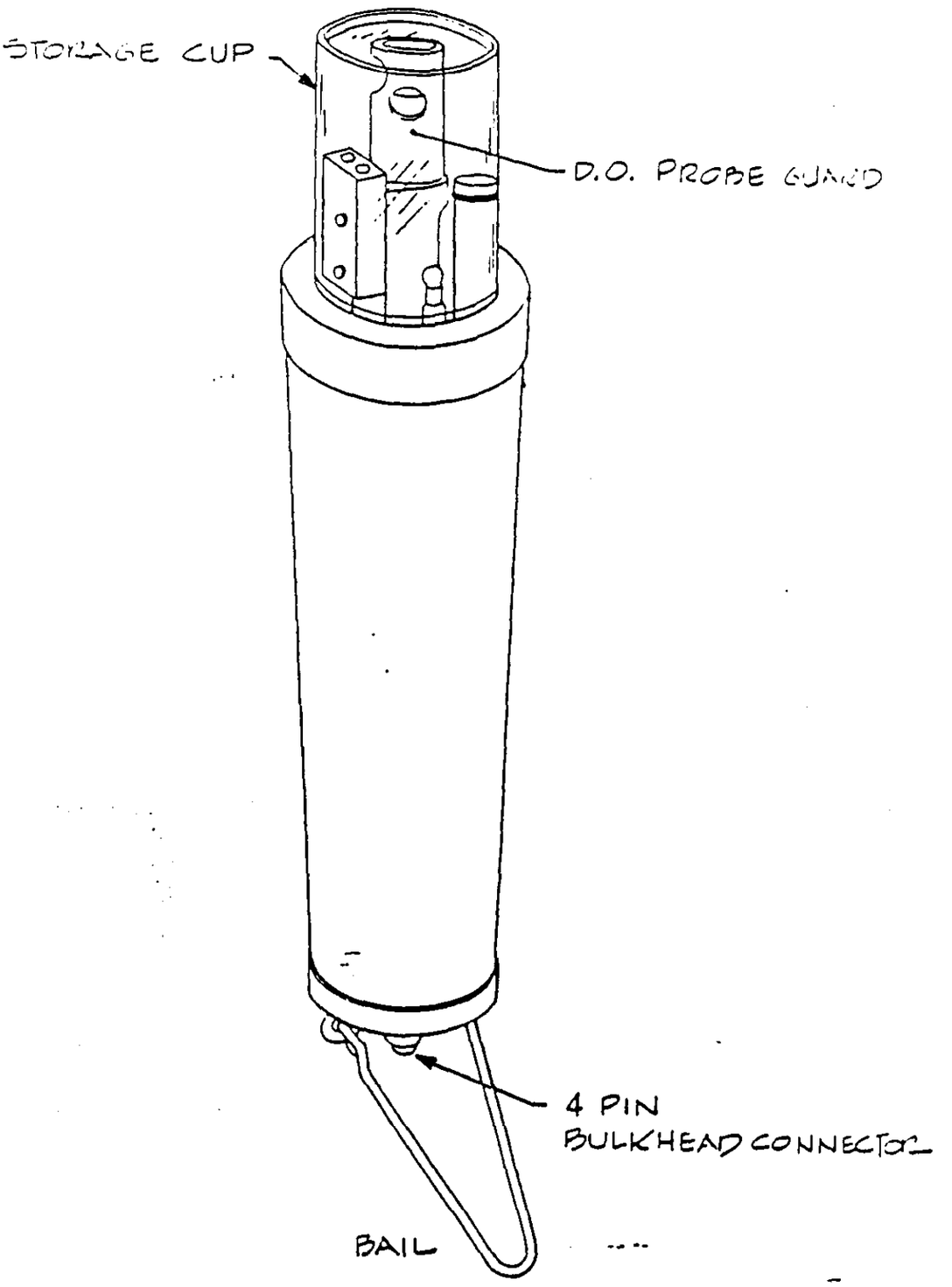
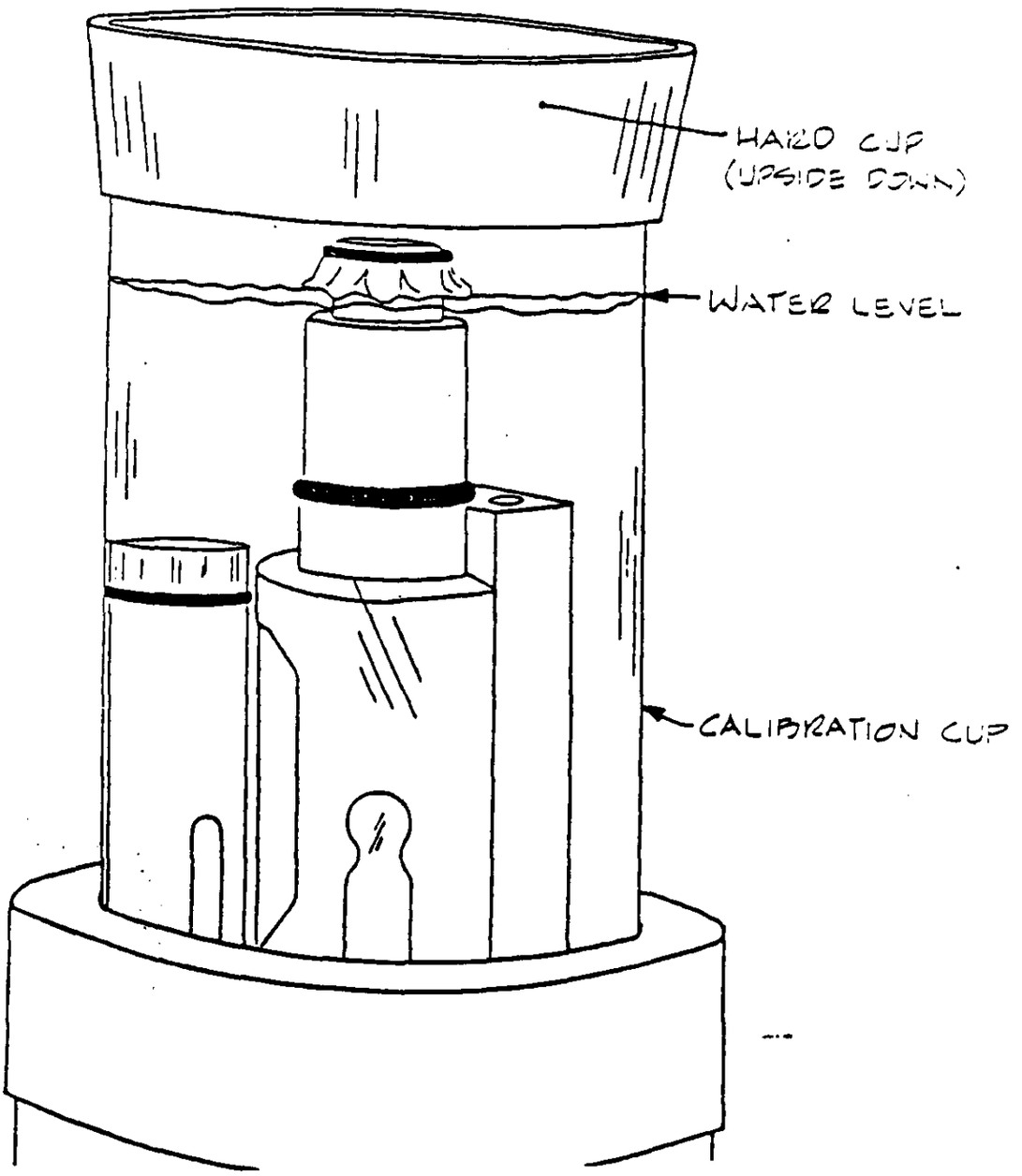


FIGURE 7. D.O. Calibration Mode - Detail



APPENDIX B

OXYGEN SOLUBILITY AT INDICATED PRESSURE (mHg)
SOP #2139
NOVEMBER, 1990

--TABLE 1--

OXYGEN SOLUBILITY AT INDICATED PRESSURE mmHg

T,DEG C	P(H20)	760	755	750	745	740	735	730
0	4.58	14.57	14.47	14.38	14.28	14.18	14.09	13.99
1	4.93	14.17	14.08	13.98	13.89	13.79	13.70	13.61
2	5.29	13.79	13.70	13.61	13.52	13.42	13.33	13.24
3	5.68	13.43	13.34	13.25	13.16	13.07	12.98	12.90
4	6.10	13.08	12.99	12.91	12.82	12.73	12.65	12.56
5	6.54	12.74	12.66	12.57	12.49	12.40	12.32	12.23
6	7.01	12.42	12.34	12.26	12.17	12.09	12.01	11.93
7	7.51	12.11	12.03	11.95	11.87	11.79	11.71	11.63
8	8.04	11.81	11.73	11.65	11.57	11.50	11.42	11.34
9	8.61	11.53	11.45	11.38	11.30	11.22	11.15	11.07
10	9.21	11.26	11.19	11.11	11.04	10.96	10.89	10.81
11	9.84	10.99	10.92	10.84	10.77	10.70	10.62	10.55
12	10.52	10.74	10.67	10.60	10.53	10.45	10.38	10.31
13	11.23	10.50	10.43	10.36	10.29	10.22	10.15	10.08
14	11.99	10.27	10.20	10.13	10.06	10.00	9.93	9.86
15	12.79	10.05	9.98	9.92	9.85	9.78	9.71	9.65
16	13.63	9.83	9.76	9.70	9.63	9.57	9.50	9.43
17	14.53	9.63	9.57	9.50	9.44	9.37	9.31	9.24
18	15.48	9.43	9.37	9.30	9.24	9.18	9.11	9.05
19	16.48	9.24	9.18	9.12	9.05	8.99	8.93	8.87
20	17.54	9.06	9.00	8.94	8.88	8.82	8.75	8.69
21	18.65	8.88	8.82	8.76	8.70	8.64	8.58	8.52
22	19.83	8.71	8.65	8.59	8.53	8.47	8.42	8.36
23	21.07	8.55	8.49	8.43	8.38	8.32	8.26	8.20
24	22.38	8.39	8.33	8.28	8.22	8.16	8.11	8.05
25	23.76	8.24	8.18	8.13	8.07	8.02	7.96	7.90
26	25.21	8.09	8.03	7.98	7.92	7.87	7.81	7.76
27	26.74	7.95	7.90	7.84	7.79	7.73	7.68	7.62
28	28.35	7.81	7.76	7.70	7.65	7.60	7.54	7.49
29	30.04	7.68	7.63	7.57	7.52	7.47	7.42	7.36
30	31.82	7.55	7.50	7.45	7.39	7.34	7.29	7.24
31	33.70	7.42	7.37	7.32	7.27	7.22	7.16	7.11
32	35.66	7.30	7.25	7.20	7.15	7.10	7.05	7.00
33	37.73	7.18	7.13	7.08	7.03	6.98	6.93	6.88
34	39.90	7.07	7.02	6.97	6.92	6.87	6.82	6.78
35	42.18	6.95	6.90	6.85	6.80	6.76	6.71	6.66
36	44.56	6.84	6.79	6.74	6.70	6.65	6.60	6.55
37	47.07	6.73	6.68	6.64	6.59	6.54	6.49	6.45
38	49.69	6.63	6.58	6.54	6.49	6.44	6.40	6.35
39	52.44	6.52	6.47	6.43	6.38	6.34	6.29	6.24
40	55.32	6.42	6.37	6.33	6.28	6.24	6.19	6.15
41	58.34	6.32	6.27	6.23	6.18	6.14	6.09	6.05
42	61.50	6.22	6.18	6.13	6.09	6.04	6.00	5.95
43	64.80	6.13	6.09	6.04	6.00	5.95	5.91	5.87
44	68.26	6.03	5.99	5.94	5.90	5.86	5.81	5.77
45	71.88	5.94	5.90	5.85	5.81	5.77	5.72	5.68

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-TABLE 1 CONTINUED-

T,DEG C	725	720	715	710	705	700	695	690
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86
2	13.15	13.06	12.97	12.88	12.79	12.69	12.60	12.51
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56
6	11.84	11.76	11.68	11.60	11.51	11.43	11.35	11.27
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21
11	10.48	10.40	10.33	10.26	10.18	10.11	10.04	9.96
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.74
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52
14	9.79	9.72	9.65	9.58	9.51	9.45	9.38	9.31
15	9.58	9.51	9.44	9.38	9.31	9.24	9.18	9.11
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37
20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59
25	7.85	7.79	7.74	7.68	7.62	7.57	7.51	7.46
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70
32	6.95	6.90	6.85	6.80	6.75	6.70	6.64	6.59
33	6.83	6.78	6.73	6.68	6.63	6.58	6.53	6.48
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38
35	6.61	6.56	6.51	6.47	6.42	6.37	6.32	6.27
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98
39	6.20	6.15	6.11	6.06	6.01	5.97	5.92	5.87
40	6.10	6.06	6.01	5.96	5.92	5.87	5.83	5.78
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34

-TABLE 1 CONTINUED-

DEG C	685	680	675	670	665	660	655	650
0	13.12	13.03	12.93	12.83	12.74	12.64	12.54	12.45
1	12.76	12.67	12.57	12.48	12.39	12.29	12.20	12.11
2	12.42	12.33	12.24	12.15	12.05	11.96	11.87	11.78
3	12.09	12.01	11.92	11.83	11.74	11.65	11.56	11.47
4	11.78	11.69	11.61	11.52	11.43	11.35	11.26	11.17
5	11.47	11.39	11.30	11.22	11.13	11.05	10.96	10.88
6	11.18	11.10	11.02	10.94	10.85	10.77	10.69	10.61
7	10.90	10.82	10.74	10.66	10.58	10.50	10.42	10.34
8	10.63	10.55	10.48	10.40	10.32	10.24	10.16	10.08
9	10.38	10.30	10.23	10.15	10.07	10.00	9.92	9.84
10	10.14	10.06	9.99	9.91	9.84	9.76	9.69	9.61
11	9.89	9.82	9.74	9.67	9.60	9.52	9.45	9.38
12	9.67	9.59	9.52	9.45	9.38	9.31	9.24	9.16
13	9.45	9.38	9.31	9.24	9.17	9.10	9.03	8.96
14	9.24	9.17	9.10	9.03	8.97	8.90	8.83	8.76
15	9.04	8.97	8.91	8.84	8.77	8.70	8.64	8.57
16	8.84	8.78	8.71	8.64	8.58	8.51	8.45	8.38
17	8.66	8.60	8.53	8.47	8.40	8.34	8.27	8.21
18	8.48	8.42	8.35	8.29	8.23	8.16	8.10	8.04
19	8.31	8.25	8.18	8.12	8.06	8.00	7.94	7.87
20	8.14	8.08	8.02	7.96	7.90	7.84	7.78	7.72
21	7.98	7.92	7.86	7.80	7.74	7.68	7.62	7.56
22	7.83	7.77	7.71	7.65	7.59	7.53	7.47	7.42
23	7.68	7.62	7.57	7.51	7.45	7.39	7.34	7.28
24	7.54	7.48	7.42	7.37	7.31	7.25	7.20	7.14
25	7.40	7.34	7.29	7.23	7.18	7.12	7.06	7.01
26	7.26	7.21	7.15	7.10	7.04	6.99	6.93	6.88
27	7.14	7.08	7.03	6.97	6.92	6.87	6.81	6.76
28	7.01	6.96	6.90	6.85	6.80	6.74	6.69	6.64
29	6.89	6.84	6.79	6.73	6.68	6.63	6.58	6.52
30	6.77	6.72	6.67	6.62	6.57	6.51	6.46	6.41
31	6.65	6.60	6.55	6.50	6.45	6.40	6.35	6.30
32	6.54	6.49	6.44	6.39	6.34	6.29	6.24	6.19
33	6.43	6.38	6.34	6.29	6.24	6.19	6.14	6.09
34	6.33	6.28	6.24	6.19	6.14	6.09	6.04	5.99
35	6.22	6.18	6.13	6.08	6.03	5.98	5.93	5.88
36	6.12	6.08	6.03	5.98	5.93	5.88	5.84	5.79
37	6.02	5.97	5.93	5.88	5.83	5.79	5.74	5.69
38	5.93	5.88	5.84	5.79	5.74	5.70	5.65	5.60
39	5.83	5.78	5.74	5.69	5.64	5.60	5.55	5.51
40	5.74	5.69	5.65	5.60	5.55	5.51	5.46	5.42
41	5.64	5.60	5.55	5.51	5.46	5.42	5.37	5.33
42	5.55	5.51	5.46	5.42	5.37	5.33	5.28	5.24
43	5.47	5.42	5.38	5.34	5.29	5.25	5.20	5.16
44	5.38	5.33	5.29	5.25	5.20	5.16	5.11	5.07
45	5.29	5.25	5.21	5.16	5.12	5.08	5.03	4.99

-TABLE 1 CONTINUED-

T,DEG C	645	640	635	630	625	620	615	610
0	12.35	12.26	12.16	12.06	11.97	11.87	11.77	11.68
1	12.01	11.92	11.82	11.73	11.64	11.54	11.45	11.36
2	11.69	11.60	11.51	11.41	11.32	11.23	11.14	11.05
3	11.38	11.29	11.20	11.12	11.03	10.94	10.85	10.76
4	11.08	11.00	10.91	10.82	10.74	10.65	10.56	10.48
5	10.80	10.71	10.63	10.54	10.46	10.37	10.29	10.20
6	10.52	10.44	10.36	10.28	10.19	10.11	10.03	9.95
7	10.26	10.18	10.10	10.02	9.94	9.86	9.78	9.70
8	10.00	9.93	9.85	9.77	9.69	9.61	9.53	9.45
9	9.77	9.69	9.61	9.54	9.46	9.38	9.30	9.23
10	9.54	9.46	9.39	9.31	9.24	9.16	9.09	9.01
11	9.31	9.23	9.16	9.09	9.01	8.94	8.87	8.79
12	9.09	9.02	8.95	8.88	8.81	8.73	8.66	8.59
13	8.89	8.82	8.75	8.68	8.61	8.54	8.47	8.40
14	8.69	8.62	8.55	8.49	8.42	8.35	8.28	8.21
15	8.50	8.44	8.37	8.30	8.23	8.17	8.10	8.03
16	8.32	8.25	8.18	8.12	8.05	7.99	7.92	7.85
17	8.14	8.08	8.02	7.95	7.89	7.82	7.76	7.69
18	7.97	7.91	7.85	7.78	7.72	7.66	7.59	7.53
19	7.81	7.75	7.69	7.62	7.56	7.50	7.44	7.38
20	7.66	7.60	7.53	7.47	7.41	7.35	7.29	7.23
21	7.50	7.44	7.38	7.32	7.26	7.20	7.14	7.08
22	7.36	7.30	7.24	7.18	7.12	7.06	7.00	6.94
23	7.22	7.16	7.10	7.05	6.99	6.93	6.87	6.81
24	7.08	7.03	6.97	6.91	6.85	6.80	6.74	6.68
25	6.95	6.90	6.84	6.79	6.73	6.67	6.62	6.56
26	6.82	6.77	6.71	6.66	6.60	6.55	6.49	6.44
27	6.70	6.65	6.59	6.54	6.49	6.43	6.38	6.32
28	6.58	6.53	6.48	6.42	6.37	6.32	6.26	6.21
29	6.47	6.42	6.36	6.31	6.26	6.21	6.15	6.10
30	6.36	6.31	6.25	6.20	6.15	6.10	6.05	5.99
31	6.25	6.19	6.14	6.09	6.04	5.99	5.94	5.89
32	6.14	6.09	6.04	5.99	5.94	5.89	5.84	5.79
33	6.04	5.99	5.94	5.89	5.84	5.79	5.74	5.69
34	5.94	5.89	5.84	5.79	5.74	5.70	5.65	5.60
35	5.84	5.79	5.74	5.69	5.64	5.59	5.55	5.50
36	5.74	5.69	5.64	5.60	5.55	5.50	5.45	5.41
37	5.64	5.60	5.55	5.50	5.46	5.41	5.36	5.31
38	5.56	5.51	5.46	5.42	5.37	5.32	5.28	5.23
39	5.46	5.41	5.37	5.32	5.28	5.23	5.18	5.14
40	5.37	5.33	5.28	5.24	5.19	5.14	5.10	5.05
41	5.28	5.24	5.19	5.15	5.10	5.06	5.01	4.97
42	5.20	5.15	5.11	5.06	5.02	4.97	4.93	4.88
43	5.12	5.07	5.03	4.98	4.94	4.90	4.85	4.81
44	5.03	4.98	4.94	4.90	4.85	4.81	4.77	4.72
45	4.95	4.90	4.86	4.82	4.77	4.73	4.69	4.65